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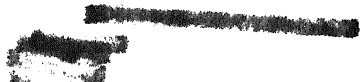
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DEVELOPMENT OF A UNITIZED SCHOOL BUS

Summary Report—Volume I*

by

L. Adams, A. Khadikar, L. Pauls, and W. Rup

AMF Advanced Systems Laboratory

Abstract

The development of new design concepts for school bus body structures and for passively restraining school bus passengers were the major objectives of this program. Passenger protection in front and rear rigid barrier impacts and in a side impact with a rigid pole—all at a 30-mph impact velocity—were the design goals. A unitized bus configuration was specified wherein the body and chassis frame are a single integrated structure in contrast to the typical school bus configuration where the body is bolted onto a chassis frame.

Analyses and development tests indicated the feasibility of providing a uniform level of protection to seated occupants, ranging in size from a 6-year-old child to a 50th percentile adult male in the front and rear impacts. In the side impact with a rigid pole at 30 mph, the hazard zone existing in the vicinity of the impacted area precludes uniform levels of protection for all occupants.

Design layouts of a 55-passenger operational school bus incorporating the unitized body structure and passive restraint systems were prepared.

1.0 INTRODUCTION

The objective of the program was to investigate feasible new concepts in school bus designs that would provide increased structural integrity and occupant

protection in crash events at impact speeds up to 30 mph. The basic design configuration was required to be one with unitized construction wherein the bus body and its chassis frame are integrated into a single unit, normally by welding. In contrast, the conventional school bus construction utilizes a separate body and a chassis frame which are bolted together.

In addition to increased structural integrity and occupant protection, the development program had as its goals a projected manufacturing cost of the unitized school bus no greater than that of a typical 66-passenger school bus and an unloaded weight no greater than that of the same typical school bus.

The sections that follow present a summary of the investigations conducted in developing the occupant restraint system and the unitized body structure and the descriptions of the operational configuration of a unitized school bus.

2.0 OCCUPANT PROTECTION

As a design goal, the bus occupants are to be protected in frontal and rear impacts with a rigid barrier at 30 mph, and in a side impact with a rigid pole at 30 mph. For each impact condition, injury criteria were specified for three occupant sizes: a 50th percentile 6-year-old child, a 5th percentile adult female, and a 50th percentile adult male. The attainment of the protective goals was determined by development sled tests of the occupant protection systems. A passive restraint approach was specified.

The specific design consideration and the development of the occupant restraint designs for each impact condition are the subjects of this section.

* Volume II, Technical Report (HS-802 005), and Volume III, Appendices (HS-802 006), are sold by the National Technical Information Service, Springfield, Va. 22151. These reports were prepared under contract DOT-HS-4-00969 with the National Highway Traffic Safety Administration.

2.1 FRONTAL IMPACT

The injury criteria stipulated for frontal impacts at 30 mph were as follows:

- Head—resultant acceleration at the center of gravity of the head not to exceed a HIC (head injury criterion) of 1,000.
- Thorax—resultant acceleration at the center of gravity of the upper thorax not to exceed 60 g's except for intervals whose cumulative duration is not more than 3 milliseconds.
- Femur—maximum axial force not to exceed:
1,700 pounds for a 50th percentile adult male
1,000 pounds for a 5th percentile adult female
600 pounds for a 50th percentile 6-year-old child

The simplest concept for passively restraining occupants is one whereby the seat is designed to absorb the energy of impacting occupants so that the forces they experience are within the injury criteria limits. In frontal impacts, the rear of each passenger seat is the contacted area and the seat design must consider not only the range of energy to be absorbed as a result of a mix of occupant sizes but also the phasing of body motions as the occupants contact the rear of the seat.

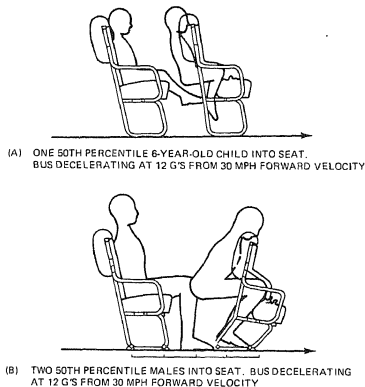


Figure 1. PASSENGER SEAT, Design Considerations

The minimum energy to be absorbed is that of a 50th percentile 6-year-old child contacting the seat when the bus is decelerating during a frontal crash

with a rigid barrier at 30 mph. The maximum energy to be absorbed during this crash mode is that of two 50th percentile adult males (each weighing 164 pounds).

Figure 1 depicts the design considerations for a passenger seat that will absorb the energy of contacting occupant(s) and control the phasing of occupant body motions during the contact period. The concept of body phasing is one whereby the head, torso, and knees of an occupant are involved in the energy absorbing process simultaneously, rather than sequentially, so as to minimize any whipping motions of these body segments.

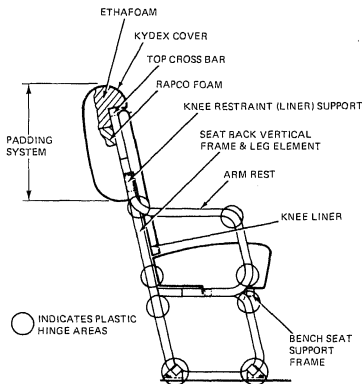


Figure 2. PASSENGER SEAT, Basic Design Concept

The prime energy absorbing mechanisms for the child's contact with the seat are: (1) a head and torso padding system and (2) a deformable knee liner. For the two adult males, an additional mechanism is a yielding seat frame structure which absorbs the major part of the impact energy through the development of plastic hinges at eight points in the frame. The simultaneous involvement of the cited energy absorbing mechanisms during a crash event provides the desired body phasing of the contacting occupant.

The passenger seat design that provides the desired protective mechanisms and body phasing is shown in Figure 2. This design incorporates the following key components:

ing) elements of the frame consist of 1" square 1010 HRS tubing with a .065" wall and 3/4" diameter CRS 1018 round tubing with a .125" wall inserted in selected portions of the square tubing.

- Knee liner—.018" thick 1010 HRS sheet intermittently welded to two cross-members in the frame structure.
- Padding system—Ethafoam 225 (polyurethane) and Rapco foam (urea-formaldehyde) covered by a vacuum-formed Kydex (acrylic-PVC) skin.

The top of the seat was specified at 20" above the H point.

The other functional parts of the seat (bench seat, back pad and scuff pad) follow conventional school bus seat design practice.

Seat assemblies, incorporating the design changes indicated by the findings of development tests of the key components, were subjected to a sled test simulating a frontal crash of the bus with a rigid barrier at 30 mph. The test configuration consisted of three seats mounted in tandem on a sled test buck. The second seat was occupied by a 50th percentile 6-year-old child dummy and the third seat by two 50th percentile adult male dummies; this configuration represents a worst-case occupant seating arrangement during a frontal impact. The crash pulse, a 12 g square wave with a duration of approximately 120 milliseconds, simulated the predicted response of the front end structure of the bus in a 30 mph barrier impact.

Figures 3 and 4 depict the trajectories as a function of time (t, in milliseconds) of one adult dummy and of the child dummy respectively throughout the simulated crash test. The body phasing of both adult dummies was good as they contacted the rear of the child's seat and there was little tendency of the dummies to be forced into an upright (standing) position. Only six of the eight required plastic hinges developed in the sides of the child's seat frame. The absence of these two resisting moments resulted in increased yielding of the seat frame and as a consequence, a physical interaction between the tops of the first and second seats occurred at approximately 145 milliseconds into the crash event.

Prior to the seat interaction, the child dummy contacted the rear of the first seat and underwent good body phasing as the head and torso padding system

Table 1 lists the occupant protection goals for the 30 mph frontal impact and compares these with the corresponding values obtained from the sled test data and from the analytical predictions.

Table 1. Test Data from 30 MPH Forward Impact Test of Passenger Seats

Head Injury Criterion (HIC)	Contract Goal (HIC)	Test Data	Analytical Prediction		
Left 50th % adult male	<1000	156	N/A		
Right 50th % adult male	<1000	153	N/A		
50th % 6-year-old child	<1000	1010 (542) *	N/A		
Chest Acceleration		Max. Avg.	Max.	Avg.	
Left 50th % adult male	<60 g	32 g 12.2 g	42 g	15.8 g	
Right 50th % adult male	<60 g	34 g 12.2 g	42 g	15.8 g	
50th % 6-year-old child	<60 g	64 g 30 g	60 g	45 g	
Femur Load	Contract Goal (HIC)	Max.	Avg.	Max.	Avg.
Left 50th % adult male	<1700				
Left Leg		1660 #	210 #	1200 #	750 #
Right Leg		2000 #	200 #	1200 #	750 #
Right 50th % adult male	<1700				
Left Leg		1270 #	350 #	1200 #	750 #
Right Leg		1170 #	210 #	1200 #	750 #
50th % 6-year-old child	<600				
Left Leg		1260 #**		N/A	
Right Leg		220 #	200 #	N/A	

* Prior to seat interaction

** Poor load cell signal

The computed HIC values for the adult dummies were very satisfactory as was that of the child dummy prior to the seat interactions; after interaction, its HIC value only marginally exceeded the goal of 1,000. Similarly, the measured chest forces on the adult dummies were low. The maximum chest force of the child dummy was predicted to be at the limit of 60 g's and the measured maximum was 64 g's; the average chest acceleration was less than predicted.

The leg of one adult dummy had a measured maximum femur load of 2,000 pounds while all other adult femur loads were less than the 1,700 pound maximum goal. The femur loads on the child dummy

are believed to be satisfactory, as noted in Table 1, one high femur load reading was directly traceable to faulty instrumentation and the other femur load was within the desired goal.

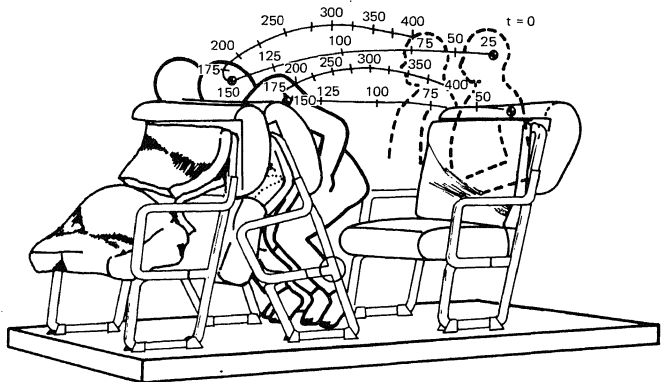


Figure 3. TRAJECTORY OF ADULT DUMMY, 30 mph Frontal Impact Test

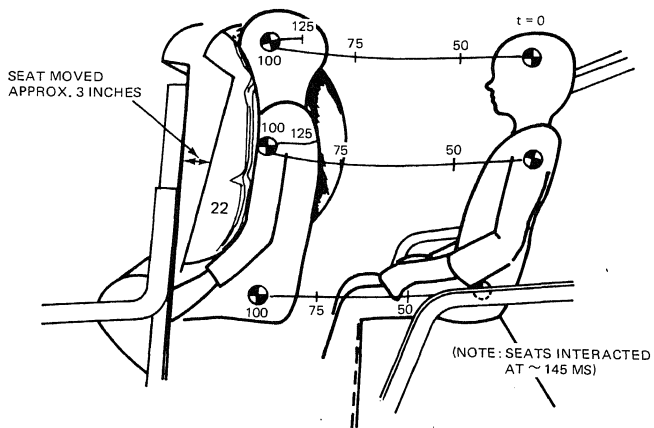


Figure 4. TRAJECTORY OF CHILD DUMMY, 30 mph Frontal Impact Test

Table 2. Test Data from 30 MPH Rearward Impact Test of Passenger Seats

Head Injury Criterion (HIC)	Contract Goal (HIC)	Test Data	Analytical Prediction	
Left 50th % adult male	<1000	107	N/A	
Right 50th % adult male	<1000	142	N/A	
50th % 6-year-old child	<1000	76	N/A	
Chest Acceleration		Max. Avg.	Max. Avg.	
Left 50th % adult male	<60 g	22 g 11 g	24 g 15 g	
Right 50th % adult male	<60 g	22 g 10 g	24 g 15 g	
50th % 6-year-old child	<60 g	27 g 15 g	N/A	
Femur Load				
Left 50th % adult male				
Left Leg	<1700 #	210 # 150 #	N/A	
Right Leg	<1700 #	170 # 130 #	N/A	
Right 50th % adult male				
Left Leg	<1700 #	160 # 130 #	N/A	
Right Leg	<1700 #	220 # 160 #	N/A	
50th % 6-year-old child				
Left Leg	<600 #	0	N/A	
Right Leg	<600 #	0	N/A	

Based on an analysis of the test data, it was determined that no seat interaction would have occurred and the injury criteria goals would have been met had the test impact speed been 26 mph (the actual test speed was 31.4 mph). This analysis (and revisions made to the seat design as a result of the test findings) also indicated that it is feasible to provide the desired occupant protection levels in the 30 mph frontal impact.

2.2 REARWARD IMPACT

The injury criteria stipulated for rearward impacts at 30 mph are the same as those specified for the frontal impact. In the sled test simulating this impact, the test configuration consisted of two seats mounted in tandem on the test buck. Two adult male dummies were placed in the first (forward) seat and a child dummy in the next seat. The crash

pulse was the same as used for the frontal impact test. Table 2 lists the occupant protection goals for the 30 mph rearward impact and compares these with the corresponding values obtained from the sled test data and from the analytical predictions. All measured force levels on the dummies were at relatively low levels, well within the stipulated goals, and the analytical predictions of the chest force levels, again, correlated very well with the measured test levels.

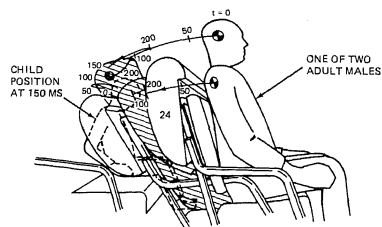


Figure 5. Trajectory of Dummies

Analysis of the high-speed motion pictures of this test indicated a need for a seat back height greater than the specified 20 inches above the H point. The trajectories of the dummies during this test (as reconstructed from the test films), shown in Figure 5, reveal the severe head and neck rotation experienced by the adult dummy and the coincidence of adult and child heads along their lateral axis at 150 milliseconds after the onset of the crash pulse. Since the child dummy was positioned between the two adult dummies, no head contacts occurred; had the child been positioned directly behind one of the adults, head contact would have occurred because the adult head and neck extended into the child's seating space.

2.3 SIDE IMPACT

The specified side impact condition is one that involved a collision with a rigid pole at 30 mph. The injury criteria stipulated for this impact mode were as follows:

- Head—resultant acceleration at the center of gravity of the head not to exceed a HIC of 1,000.

- Thorax—resultant acceleration at the center of gravity of the upper thorax not to exceed 30 g's except for intervals whose cumulative duration is not more than 3 milliseconds.

Since there are a number of variables associated with a side impact with a rigid pole, the test conditions were not specified by NHTSA; rather, AMF conducted a study of these variables and their influence on the protection levels that could be afforded occupants during this collision. The study established feasible restraint system constraints and recommended a set of test conditions. For sled tests of the restraint system, the study recommended a speed of 21.4 mph to account for "spin-out" effects imposed on a seat location three bays forward of the bay impacted by the pole. (See Section 3, Unintended Body Structure, for additional data on this impact configuration).

The restraint system for occupant protection during side impact consists of the passenger seat and a padded window assembly at the outboard side of each seat. The sled tests of the restraint system included a simulation of a side impact where seated occupants would be thrown towards the aisle and a simulation where they would be thrown towards the window.

The deceleration pulse for both simulations had a near-trapezoidal wave form with a peak of approximately 16 g's and a duration of 80 milliseconds.

The aisle side test was conducted with an uninstrumented adult male dummy to determine its kinematics (by means of high-speed motion pictures) during this simulated impact.

Table 3. Test Data from 21.4 MPH Side Impact (Toward Window) Test of Passenger Seats

Head Injury Criterion (HIC)	Contract Goal (HIC)	Test Data	Analytical Prediction
50th % adult male	1000	418	N/A
50th % 6-year-child	1000	108	N/A
Chest Acceleration		Max. Avg.	
50th % adult male	30 g	31 g 23 g	30 g max.
50th % 6-year-old child	30 g	20 g 14 g	N/A
Pelvic Acceleration			
50th % adult male	None	31 g 23 g	30 g max.

The recorded data from the test where the seated occupants were thrown towards the window are presented in Table 3, and the trajectories of the adult and child dummies are depicted in Figure 6. This data indicates that the measured force levels on the

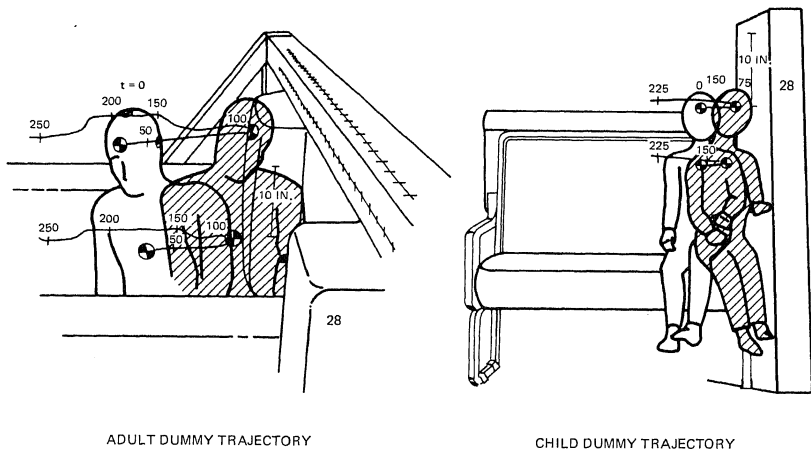


Figure 6. 21.4 mph Side Impact (Toward Window) Test

dummies were acceptable and the restraint system functioned effectively. When the adult dummy contacted the window padding, his head penetrated the padding approximately 3 inches and his torso penetration was approximately 6 inches. Since the total padding thickness on the window was 6½ inches, a torso penetration of 6 inches effectively “bottomed-out” the padding and resulted in the maximum acceleration of 31 g’s measured at the adult male dummy’s chest.

3.0 UNITIZED BODY STRUCTURE

The development of the unitized body structure was concerned primarily with obtaining a specific structural response for each of the stipulated crash modes. The structural requirements associated with each of the crash modes were as follows:

- **Front and Rear Impacts**—In these rigid barrier impacts at 30 mph, the desired response of the front and rear ends of the body structure is a controlled structural crush with a deceleration level that can be accommodated by the occupant restraint system.
- **Side Impact**—In this crash mode, involving an impact with a rigid pole at 30 mph, dimensional constraints on the body width limit the amount of crush that can be tolerated; a minimum of pole intrusion into the occupant seating space is desired.
- **Rollover**—Structural integrity to prevent roof collapse is the primary requirement in a rollover. For this mode, the maximum intrusion of the roof into the passenger compartment is not to exceed a plane 65 inches above the floor line. Further, the body structure is to withstand a diagonal roof load six times the gross vehicle weight (GVW) of the bus.

In addition to the cited crashworthiness requirements, the unitized body structure is required to withstand the riding loads encountered in its normal transportation functions and to accommodate all other systems that comprise an operational school bus.

The operational configuration of the unitized body structure is shown in Figure 7. Except for the external skins, the basic structure is a welded assembly of the following major structural elements:

- **Roof bow and side posts** (a welded subassembly forming a continuous frame).
- **Subframe** (a welded subassembly).

- **Side post to subframe lateral braces** (used to join the side posts to the subframe).
- **Longitudinal stringers** (used to join all roof bows and side posts).

This welded assembly (with the addition of other structural elements, wheel-well framing, gussets, braces, etc.), in effect, forms a continuous space frame.

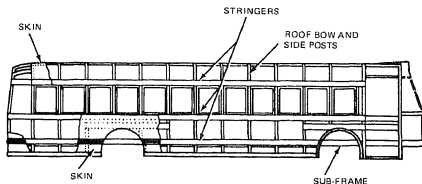


Figure 7. Unitized Body Structure

The body structure is completed with the addition of the external skins (riveted), wheel well covers (welded), and flooring (bolted). The subframe is used to support the chassis systems (engine, suspensions, steering, fuel tank, air tanks, etc.) and its forward and rear portions incorporate the structural elements that provide the energy management systems during front and rear impacts.

3.1 FRONT AND REAR ENERGY MANAGEMENT SYSTEMS

The front and rear ends of the body structure incorporate structural elements to manage the energy of the 30-mph front and rear barrier impacts. Both systems are designed to decelerate the bus at an average of about 12 g’s; the corresponding crush for a 30-mph velocity change is 30 inches. Computer simulations of occupant behavior during impact with a properly designed energy-absorbing seat have shown that acceptable head and chest accelerations and femur loads are obtained with a crash pulse approximated by a 12 g constant deceleration.

For a 15,100-pound bus with a 5,400-pound passenger load undergoing a 30-mph velocity change, the energy which must be absorbed by the bus structure is estimated (conservatively) at 522,000 ft-lbs_f (forcé) in a frontal impact and 517,000 ft-lbs_f in a rear impact. The slightly larger value in the rear impact is due to close coupling of the passenger load to the structure in this case.

The systems use 6" x 6" x 3/16" square tubes (A500 Grade B steel) as the major energy-absorbing elements; these members continue into the bus subframe past the axles and bear a major portion of the operational loads applied by the suspension systems. The energy absorbing tubes are located at a height which provides a good structural interface with the frames of those vehicles large enough to cause significant crush of the bus structure, while the bumper extends down low enough to engage automobile bumpers and frames and prevent underride.

Crush tests were conducted on full-size (6" x 6" x 3/16") tubes to develop designs that would provide the desired crush characteristics. The test results indicated that two such tubes would be adequate to absorb all but a small fraction of the required energy; the remainder would be handled by other structural elements involved in the impact.

3.2 SIDE IMPACT

A parametric study was conducted to determine whether or not the goal of providing uniform protection to all occupants when the bus is involved in a 30-mph side impact with a rigid pole could be met. The variables considered in this study included occupant size, spacing between occupants and between an occupant and side padding, padding thickness, seating location with respect to point of impact, and impact symmetry. The study concluded that uniform protection for all occupants in this 30-mph impact was not feasible.

At the point of impact, the protective padding accelerates instantly and the occupant in that area contacts the padding at impact speed and derives no benefit from vehicle ride-down. Outside of the hazard zone around the impact point, occupants benefit significantly from vehicle ride-down. In symmetrical impacts, the benefit is uniform over the length of the bus; in unsymmetrical impacts, the benefit increases with the distance away from the impact point. For an unsymmetrical impact where the pole impacts the bus in a bay behind the rear wheel well, the study found that an occupant seated three bays forward of the impacted bay would probably survive. This impact configuration was selected as the one to be used in the development tests of the unitized body structure. Prior tests of school buses conducted by Dynamic Science, Ultrasystems, Inc., involved very similar test conditions so data was available for com-

paring the responses of the unitized body structure with those of typical school buses.

The test vehicle used in the development tests, shown in Figure 8, consisted of a complete rear half of the unitized body with ballast to simulate the mass properties of a fully-loaded operational bus. Bay 4, three bays forward of the pole impact area, contained the occupant restraint system for side impacts; the system consisted of a pair of passenger seats and a padded window assembly. The dolly-mounted test vehicle, with an instrumented 50th percentile adult male dummy seated in Bay 4, was driven into a 14" diameter rigid pole at 31.4 mph; the impacted area was Bay 7.

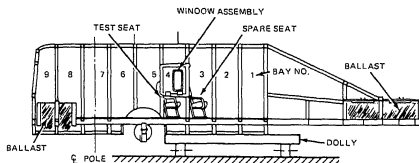


Figure 8. Test Vehicle Configuration for Side Pole Test

The design objectives, analytical predictions, and measured data for this side impact test are summarized in Table 4. For comparison purposes, the test data from prior side pole impact tests at 20 mph using a typical (baseline) school bus and a structurally improved school bus are also listed. The test findings show that the unitized body structure and the occupant restraint system met the design objectives and that the test data correlated very well with the analytical predictions of the body structure performance. A detailed analysis of the test data and a post-test examination of the vehicle identified a number of minor structural design modifications required to reduce material fracture during such an impact.

3.3 ROLLOVER

As noted previously, structural integrity of the body structure to prevent roof collapse is the primary requirement in a rollover accident. The design adequacy of the unitized body structure was determined analytically for two loading cases: a static vertical roof load of 1.5 x GVW (33,000 pounds) and a static diagonal roof load of 6 x GVW (24,500 pounds) on three roof bows (a test condition). The latter load case was the subject of a development test.

Measurement	Contract Design Objectives	AMF Analytical Predictions	AMF Half Bus Test Results	Dynamic Science 20-mph Side Pole Impact	
				Baseline Vehicle	Improved Vehicle
Impact Speed	30 mph	30 mph	31.4 mph	21.3 mph	19.9 mph
Vehicle Average Acceleration (at point of impact)	—	~20 g's	~17 g's	~6 g's	~9 g's
Dummy Response					
Head Acceleration	—	N/A*	39 g's	N/A*	N/A*
Torso Acceleration	<30 g's	30 g's	29.5 g's	17 g's	35 g's
HIC	<1000	N/A	123	N/A	N/A
Vehicle Crush					
Dynamic	Intrusion to be minimal	21 in	25.5 in	23.1 in	15.4 in
Static		N/A*	19.3 in	16.8 in	12.6 in
Energy at Impact		7.01×10^5 ft-lbs	7.67×10^5 ft-lbs	4.12×10^5 ft-lbs	3.70×10^5 ft-lbs

* Not Available

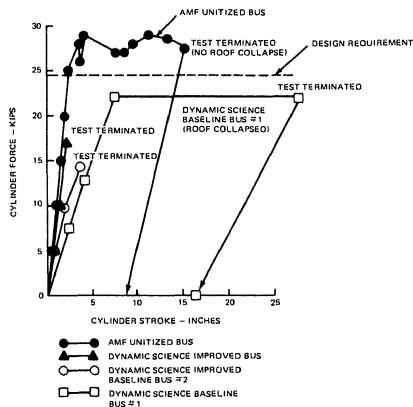


Figure 9. Comparison of Various Bus Roof Structures Diagonal Roof Load Test

For the diagonal roof load test, three bows enclosing Bays 2 and 3 (of the test vehicle used in the side pole test) were tested under the same conditions as were prior tests of typical (baseline) and improved school buses. The test involved corner loading the roof bows by means of a loading block and a hydraulic

cylinder diagonally connecting the block to ground. The data from the diagonal roof load tests of the unitized body structure and of baseline and improved school buses are depicted in Figure 9. The unitized body structure exceeded the design requirement of 24,500 pounds; the maximum measured load reached approximately 29,000 pounds.

4.0 OPERATIONAL CONFIGURATION

Design layouts were prepared of the operational configuration of a unitized school bus incorporating the occupant restraint systems within the unitized body structure. Summary descriptions of the salient features of the operational design are the subject of this section.

4.1 EXTERNAL CONFIGURATION

The external configuration and overall dimensions of an operational bus incorporating the unitized body structure are shown in Figure 10. Its general appearance is characterized by the safety features included in its design. The front end overhang provides a structure that can crush 30 inches to limit the deceleration forces imposed on the bus occupants in a 30 mph front-barrier-type impact. To enhance the driver's direct visibility with this overhang, a four-piece windshield and a one-piece door with large glazed areas are provided.

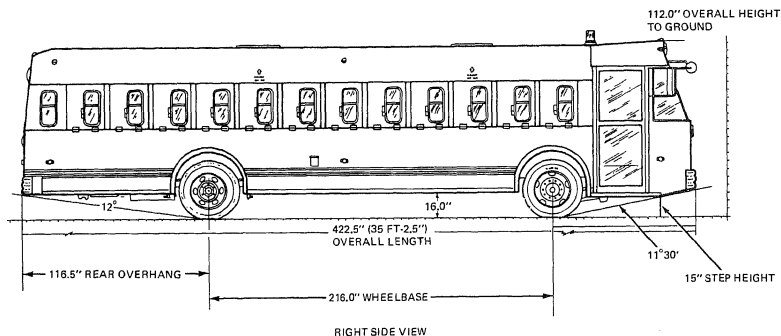


Figure 10. External Configuration, Operational Bus

The passenger window assemblies are characterized by glazed areas smaller than those in typical school buses. This is due to the energy absorbing padding on their interior surfaces, which serves to protect occupants during side impacts. Each window assembly can be used as an emergency exit with a clear opening of 22" x 26". In addition to the window exits, two emergency escape exits (each with a clear opening of 24" x 26") are provided in the roof and one emergency rear-exit door (28" x 79" opening interrupted by two 3" wide vertical posts). The remaining exterior features (lighting, signals, markings, mirrors, etc.) are typical of those on current school buses.

The estimated curb weight of the bus is 15,100 pounds and its fully loaded weight (55 passengers and driver) is estimated to be 20,500 pounds. The estimated vertical CG height is 42" and 44" for unloaded and loaded conditions respectively.

4.2 INTERNAL CONFIGURATION

Figure 11 depicts the internal configuration of the unitized bus. The 55 passengers are seated in 11 rows of seats, each row consisting of one 2-passenger and one 3-passenger seat. A typical section of the passenger compartment is characterized by the provisions for occupant restraints. Each seat provides the protective restraint for its occupants in front and rear barrier impacts.

The pertinent seat spacing dimensions are as follows:

- Fore-aft seating space—27"
- Leg room (H point to rear of next forward seat)—20.4"
- Aisle space between seats—12" (minimum)

The modesty panels in front of the first row of seats are designed to absorb energy in frontal impacts through means similar to those provided in the seats.

The seat armrests, in conjunction with energy absorbing padding on the windows and side surfaces, restrain the occupants in side impacts. In rollover accidents, the interior of the roof structure presents potentially hazardous hard surfaces to contacting occupants. To minimize this hazard source, the undersides of the stringers and bows are padded and a molded plastic liner, running between and attached to the bows, forms a ceiling surface. Upon body impact, the liner absorbs energy through membrane action.

The layout of the driver's compartment and the complement of driver's controls and displays are similar to that of typical school buses. The mirrors provided the driver include: two exterior rearview mirrors, each incorporating a convex as well as a flat mirror surface; one exterior safety cross mirror; and one inside rearview mirror. The front windshield surfaces are equipped with dual wipers and windshield washers.

The basic heating and ventilating unit provides the defrost/defog, fresh air ventilation, and heating (90,000 BTU/hour) functions. Increased heating and ventilating capacity, if required, is provided by optional add-on units.

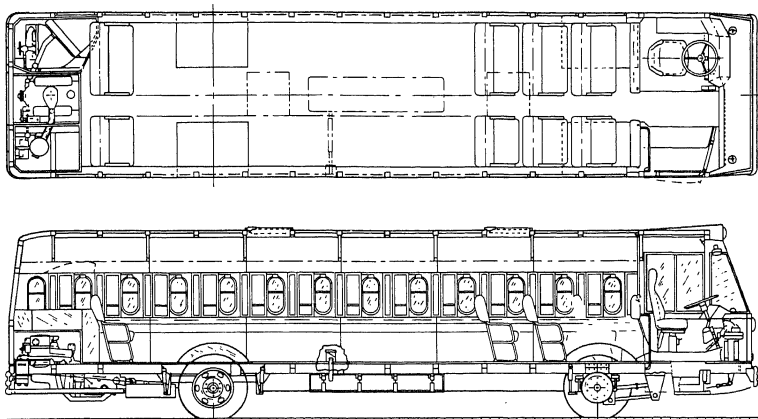


Figure 11. Internal Configuration, Operational Bus

The entry door is a one-piece sliding door (moving into the interior of the bus on opening) with large glaze areas to provide enhanced driver visibility of the boarding process. An air cylinder is used to actuate the door; the actuation system and the door are provided with safety and emergency switches to prevent the door from closing on a passenger.

4.3 CHASSIS SYSTEMS

The general arrangement of the chassis systems, shown in Figure 12, is typical of a conventional rear engine, rear-wheel-drive configuration.

The components in the rear chassis include the following:

- Engine—GMC 366, V-8, 200 net HP @ 4,000 rpm (max HP) with a GMC 7500 series cooling system.
- Transmission—Allison AT-540 4-speed automatic, 200 HP maximum input, 2.0 converter stall ratio.
- Suspension—Mor/Ryde with a spring rate of $\sim 4,600$ lb/in (constant).
- Axle—Rockwell-Standard F106B-RDA-10A, rated capacity—15,000 lbs. Axle ratio—7.20:1.
- Fuel system—60 gallon capacity fuel tank with safety valving.

The front chassis components include the following:

- Axles—Rockwell-Standard FD-931 series.
- Steering—GM Saginaw Model 553 power steering unit and GM #5697654 power steering pump.
- Suspension—Mor/Ryde with a spring rate of $\sim 1,900$ lb/in (constant).

The brake system is air actuated with four-wheel anti-skid controls and meets the requirements of FMVSS 121. The following components comprise the brake system:

- Front brakes—Rockwell-Standard TWX, S-cam type.
- Rear brakes—Rockwell-Standard RDA, wedge type.
- Actuation—Bendix-Westinghouse pneumatic with independent air circuits for front and rear brakes.
- Anti-skid—Rockwell-Standard Skid-Trol (axle-by-axle system).

An analysis of the chassis systems indicates that they will provide the unitized school bus with driving and handling performance equal to or better than that of typical school buses. In particular, the suspension system design provides considerably more lateral stability than is present in conventional leaf-spring suspensions and should result in better cornering performance.

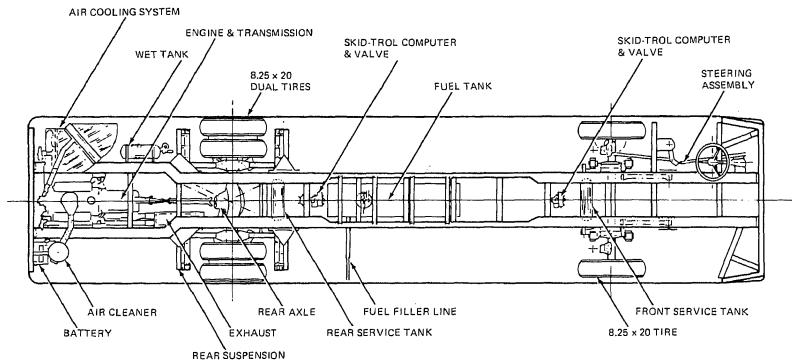


Figure 12. Chassis Systems Arrangement

4.4 AUXILIARY SYSTEMS

Except for a few additional safety features, the electrical system is a conventional 12-volt DC system. The added features include: an emergency electrical disconnect (inertia) switch in the battery circuit; a passenger window status circuit; and a fire alarm circuit.

The inertia switch serves to cut out the electrical power in a crash so as to lessen the danger of a fire arising from electrical sources.

The window status circuit provides the driver with an alarm indicating that the emergency release handle on a passenger window has been actuated and the window is being opened into its emergency exit mode.

The fire alarm circuit is part of the provisions made in the operational bus for fire safety. Since a fire in a rear-engine vehicle probably would not be quickly detected (as contrasted with a front-engine location), an over-temperature sensor is provided in the engine compartment to actuate an audible fire alarm on the driver's dashboard. For fighting such a fire, a dry chemical fire extinguisher (10B:C) with a flexible mounted nozzle is located to the left of the driver. Access to the engine compartment can be had within one minute (without the need for any power-assisted access devices) for fire extinguishing purposes. To

prevent the spreading of a fire to the interior of the bus, the engine enclosure is made of noncombustible materials.

4.5 COST FACTORS

The production cost for the operational unitized school bus was estimated to be approximately \$2500 higher than that of a typical 66-passenger school bus. The estimates were based on the major design differences between the unitized and the typical school bus configurations, namely, the use of a unitized body structure and the incorporation of the occupant restraint systems for 30-mph impact protection. The production costs of systems and equipment common to both configurations were assumed to be the same.

In terms of producibility, the majority of the operational bus designs were considered to be compatible with current school bus manufacturing practices. The most significant departure from current practice is the application of protective padding to the interior surfaces of the bus.

The maintainability of the bus was judged to be equivalent to that of conventional designs. However, more care would be required in the repair of damage to the body structure and occupant restraint systems to preserve their protective performance.

ABSTRACT CITATIONS

HS-018 298

CARBURETOR ALTITUDE COMPENSATION

Carburetor designs which are able to compensate mixture ratios for the effects of altitude change are discussed. The fundamental function and operation of a carburetor is considered. The following compensation designs are examined: the venturi bypass method using a bypass conduit for air around the venturi throat of the carburetor; the auxiliary jet method providing an auxiliary fuel metering orifice in the fuel bowl, connected in parallel with the main metering orifice; the fuel bowl back-suction method which applies a controlled amount of vacuum over the surface of fuel in the carburetor bowl; and the Carter method which employs independent air bleed circuits to each system to be compensated in the carburetor. Cross-sectional drawings of the compensation designs are included.

Publ: Automotive Engineering v84 n2 p36-9, 125 (Feb 1976)
1976

Based on SAE 0760286, "An Approach to Altitude Compensation of the Carburetor," by R. C. Wrausmann and R. J. Smith, presented at SAE Annual Meeting, Detroit, 23-27 Feb.

Availability: See publication

HS-018 299

DRINKING AND DRIVING DOWN UNDER

Drinking and driving in Australia is discussed; drinking as part of the life style; drinking patterns; excessive drinking (characteristics of excessive drinkers, and legislative measures); and the lack of controlled studies to assess the effectiveness of the enforcement of Breathalyzer legislation in reducing accidents and injuries. The need for educational programs regarding drinking and driving is discussed and special emphasis is given to the program at work in Queensland which has utilized television and brochures and will utilize a program in the schools to communicate its traffic safety message.

by Keith W. Hooper

Publ: Traffic Safety v76 n2 p8-10, 34-7 (Feb 1976)
1976

Availability: See publication

HS-018 300

A MOTOR VEHICLE ACCIDENT CAUSAL SYSTEM: THE HUMAN ELEMENT

A motor vehicle accident causal system, from a human factors viewpoint, is presented. The system or model is based on a cause and effect relationship: the effect being the primary failure or behavior which led directly to the collision situation; the cause being the reasons for the failure or behavior. Effects are described as information processing failures of four types: perception; comprehension; decision; and action failures. The reasons for these information processing errors are categorized as: physical or physiological failures; driver conditions or states; experience or exposure factors; conflicting behaviors or preoccupation; and risk-taking behaviors. A causal reporting system for utilization by accident research groups is discussed in terms of primary or principal causes, severity increasing

factors, and relevant conditions. Two recent studies which used similar causal systems are described and findings are presented. A discussion of the possible benefits of such a system as results emerge is related to driver education and training techniques.

by James C. Fell

National Hwy. Traffic Safety Administration, Washington, D.C.

1974 : 7p 17refs

See also HS-801 214.

Availability: Reference copy only

HS-018 302

PREDICTION OF THE COEFFICIENT OF FRICTION FOR PNEUMATIC TYRES [TIRES] ON HARD PAVEMENT

The relationship between the coefficient of friction and the slip of a flexible wheel, such as the pneumatic tire, plays a major role in the design of refined braking systems for vehicles. The available data being partly empirical in nature, it was desirable to be able to predict this relationship. An attempt is made to explain the mechanism defining this relationship for a pneumatic tire operating on hard pavement. The distinct roles of the flexibility of the tire and the sliding of the wheel are identified and utilized in predicting the curve. A model of the tire is proposed to explain the role of flexibility of the tire. It is shown that the suggested procedure can clearly bring out the effects of some of the operating parameters of the vehicle, such as speed, presence of contaminants in the contact path, stiffness of the tire, and vertical load on the wheel.

by Shri Kant; D. L. Prasanna Rao; M. L. Munjal
Indian Inst. of Science, Dept. of Mechanical Engineering,
Bangalore 560012 India

Publ: Institution of Mechanical Engineers, Proceedings, 1975,
v189 n34 p259-66

Rept. No. 34/75 : 1975 : 9p 8refs

Availability: Institution of Mechanical Engineers, 1 Birdcage
Walk, London SW1H 9JJ England

HS-018 303

INJURIES TO CAR OCCUPANTS--THEORETICAL CONSIDERATIONS

A method is described for calculating the percentages of fatal, serious, slight and uninjured occupants in collisions; the first calculations being made for drivers in head-on collisions. The starting points are a diagram giving the probabilities of the four injury levels versus velocity change of the vehicle, and a distribution diagram of the percentages of head-on collisions within successive equal intervals of relative velocity at impact. Calculations of these percentages were made for ratios of the masses of the two vehicles of 1.0 to 9.0, and satisfactory agreement was found with results derived from national accident statistics. The relevance of the theory to the assessment

of the value of safety measures and the determination of human tolerance to impact is discussed.

by G. Grime
University Coll. London, Traffic Studies Group
Publ: Institution of Mechanical Engineers, Proceedings, 1975,
v189 n51 p405-16
Rept. No. 51/75; 1975; 13p 9refs
Prepared for presentation at an Ordinary Meeting of the
Institution of Mechanical Engineers, Automobile Div.,
London, 18 Nov 1975.
Availability: Institution of Mechanical Engineers, 1 Birdcage
Walk, London SW1H 9JJ England

HS-018 304

ALBERTA IMPAIRED DRIVERS' PROGRAM: FINAL REPORT ON EVALUATION

The Alberta Impaired Drivers' Program (AIDP) is evaluated in terms of a single dependent measure, impaired driver recidivism. The evaluation involves follow-up of those drivers convicted in the Edmonton (Alberta) Municipal Court during the period September 1970 through December 1971. The driving records of 1355 impaired drivers were obtained from the records of the Department of Highways and studied. It was found that: no reduction in recidivism resulted from the program; a general improvement in driving behavior was noted for persons with drinking or driving problems; and arguments were made for formative rather than summative evaluation procedures when evaluating programs like the AIDP. Data coding sheets and comparisons of AIDP and non-AIDP driver groups studied are appended.

by Paul F. Zelhart, Jr.; Bryce C. Schurr
University of Alberta, Applied Psychology Unit, Edmonton,
Alta., Canada
Rept. No. CR-7505; 1975; 85p 8refs
Availability: Ministry of Transport, Directorate of Road and
Motor Vehicle Traffic Safety, Ottawa, Canada

HS-018 305

THE DYNAMIC BEHAVIOR OF THE MOTOR CAR IN EMERGENCY MANEUVERS

Limit maneuver testing involves the objective measurement of steering and braking performance in emergency maneuvers. Tests have demonstrated that vehicles differ markedly with regard to their limit-maneuver performance characteristics. However, the extent to which the postulated open-loop measures of performance influence the limit-maneuvering performance of the closed-loop driver-vehicle system remains to be shown. While it is being proposed that objective measurements be made of the manner in which a vehicle responds to emergency control inputs, there is at present no formal consensus on what constitutes good maneuvering performance in the normal handling regime, much less on standardized, objective ways of measuring this performance. In addition, such measurement is meaningless if typical drivers are not likely to exploit the maneuvering capabilities of their vehicles in emergency situations. Thus, research designed to develop objective, discriminating test procedures to evaluate the manner in which a vehicle behaves under emergency conditions will inform only the motor vehicle design community with respect to all of the attributes possessed by the car. One problem with the current testing program is that sequential tests are conducted in order to search out the limit of performance. The destructive aspects

of the test procedure alter the properties of the system being tested, possibly invalidating results. In addition, no motor vehicle remains a fixed entity over time with respect to its ability and control characteristics, which are altered by changes in load, load distribution, replacement of the original tire variations in tire inflation pressures, and normal wear patterns. It is concluded that motor vehicle engineers can gain considerable insight and knowledge from limit-maneuver testing if the difficulties inherent in the testing process are considered.

by Leonard Segel
University of Michigan, Hwy. Safety Res. Inst.
Publ: Soc. of Automotive Engineers of Japan, Course on
Driving Simulation, Proceedings, Tokyo, n.d., p32-42
n.d.; 6refs
Availability: Reference copy only

HS-018 306

THE INFLUENCE OF MOTION AND AUDIO CUES ON DRIVER PERFORMANCE IN AN AUTOMOBILE SIMULATOR

A highway driving simulator with a computer-generated visual display, physical motion cues of roll, yaw, and lateral transition, and velocity-dependent sound/vibration cues was used to investigate the influence of these cues on driver performance. A total of 48 student subjects were randomly allocated to experimental groups. Each group of eight subjects experienced a unique combination of the motion and audio cues. The control group received a full simulation condition while each of the remaining five groups performed with certain combinations of motion and sound deleted. Each driver generated responses over minutes of continuous data from which five performance measures were derived. Results indicate that the performance measures of yaw, lateral, and velocity deviation are significantly affected by the deletion of cues. In support of this hypothesis that driver performance is augmented by the addition of motion cues, statistically significant negative correlations were obtained between the number of motion cues present and measures of yaw and lateral deviation. The following driver simulator design criteria are suggested for adequate simulation: the incorporation of at least two of the three motion cues of yaw, roll, and lateral transition; and the presentation of velocity-dependent audio cue.

by Robert C. McLane; Walter W. Wierwille
Publ: Human Factors v17 n5 p488-501 (Oct 1975)
1975; 9refs
Availability: See publication

HS-018 307

THE DRIVEN DRIVER

The problems posed by various types of irresponsible drivers are examined through colorful descriptions of driving attitudes and situations. The driver with a 'king of the road' attitude presents traffic hazards through disregard for the safety of other drivers and pedestrians and failure to yield the right of way, signal turning intentions, obey speed limits, or take accidents seriously. The novice, who may be either a new driver or an old driver who never learned safe driving, presents hazards through an immature attitude towards driving situations, such as speeding for the thrill, disregarding citations having them fixed, and paying attention to anything but

and other traffic. Driving instructors may or may not be dedicated to teaching good driving. Some instructors can create situations which leave novice drivers with a fear of driving or fail to impart vital knowledge about handling hazardous situations. Students' attitudes may also reflect a lack of understanding of the responsibility involved in driving a car. The state examiner responsible for licensing new drivers presents a final set of problems. The examiner may be affected by the sex of the applicant, nationality differences, language barriers, or parental influence. Written tests can lose some of their viability through consultation with persons who have already taken the test or cheating during the exam. Examiners may give confusing instructions during road tests, causing applicants to fail the test. Often the applicants are seriously unprepared for road tests, lacking sufficient knowledge or experience to handle a vehicle safely. An improved attitude toward the value of life and toward the economic waste caused by present driving attitudes and official attempts to relieve problems are necessary if traffic safety is to be significantly improved. Insurance companies, licensing agencies, law enforcement officials, and judicial personnel must act to pressure drivers to be more considerate and responsible on the road. An effective public program of education oriented toward preventing driver problems before they happen is needed.

by Jay Rin

1974; 123p

Availability: Dorrance and Co., Philadelphia

HS-018 308

THE INTERACTIVE EFFECTS OF CARBON MONOXIDE AND ALCOHOL ON DRIVING SKILLS

The combined effects of carbon monoxide (CO) and alcohol on driving performance in normal driving tasks are determined and "benchmarks" of performance and equivalence levels for comparing carboxyhemoglobin (COHb) effects to corresponding blood alcohol effects on driving performance are established. Research was conducted in three phases. In each phase four non-smoking college students over the age of 21 were tested. In the first two phases four treatment levels were used: 2% and 8% COHb levels with 0 and 0.05% blood alcohol concentration (BAC); and 8% and 12% COHb levels with 0.05% BAC. In the third phase two treatment levels, both COHb and BAC at 0% and 12% COHb level with 0.05% BAC, were used. The tasks employed were primarily open road driving, car following, sign reading, and curve negotiation. A 1965 Plymouth station wagon was used as the lead vehicle. A subject driver, observer, and safety man as the front seat passenger followed in a 1970 Chrysler Newport. An oscillograph system recorded distance pulses, velocity, lateral acceleration, steering wheel movement, brake pedal activation, gas pedal activation, and a stimulus signal for facilitating data reduction. An eye-marker system was used to record driver eye movement or view of the road. Total road experimentation for each session lasted about 2 1/2 to 3 hours and always the experiments were double blind. Laboratory tests were also carried out to investigate the interactive effects of CO and alcohol on performance in tests of spatial relations, mirror tracing, brightness discrimination, and rail walking. COHb effects (perceptual narrowing, decreased visual activity, time compression, and distance expansion) were observed to be significant only in tasks with higher information processing demands. CO-alcohol interaction was observed to be synergistic in driver control measures in curve negotiation tasks at 12% COHb

levels. It was concluded that, under the test conditions, 0.04% BAC will either have no interaction effect with COHb or may even offset COHb effects. There was a high correlation between task demands and the observance of subtle COHb effects.

by F. W. Weir; D. F. Johnson; D. M. Anglen; T. H. Rockwell; J. B. Neuhardt; D. J. Harshman; K. N. Balasubramanian
Ohio State Univ., Columbus, Ohio 43210
Contract EPA-68-02-0329
1975; 120p 69refs
Sponsored by the Coordinating Res. Council, CRC-APRAC
Proj. CAPM-9-69.
Availability: Corporate author

HS-018 309

IDENTIFICATION AND SURVEILLANCE OF HIGH ACCIDENT LOCATIONS. EVALUATION REPORT OF FEDERAL HIGHWAY SAFETY PROJECT

The procedures used to identify and investigate high accident locations in Milwaukee, Wisconsin are detailed. During a four-year period, nearly 400 locations were identified as having safety deficiencies. Recommendations for corrective measures were made for 258 locations, and as of March 31, 1975, 231 of these recommendations have been implemented. "Before versus After" annual average accidents are statistically analyzed for significant accident reductions. Finally, cost benefit studies are undertaken to evaluate the effectiveness of the project and determine whether such a systematically organized accident investigation program should be retained on a permanent basis in Milwaukee. Lists are provided which give the following data for each study site: location; corrective measure category; implemented date; before and after annual accident averages; significance of difference; project cost and before and after annual accident costs. Results showed the low-cost improvement projects at arterial locations accounted for 40% of the total accident cost reduction, and provided \$54/year in estimated accident savings for each improvement dollar spent. Low-cost projects at non-arterial locations accounted for 49% of the cost reduction and provided \$39/year savings per improvement dollar, while high-cost projects at arterial locations returned less than \$3/year savings per improvement dollar and showed no significant reduction in total accidents. The total project cost for the 143 locations evaluated in this report is estimated at \$195,992. This amount, which includes all four years of the overall project, is amortized in approximately five months by the estimated \$528,000 in accident costs saved in one year. The project has been a great success, and its continuation on a permanent basis has been approved.

City of Milwaukee, Dept. of Public Works, Bureau of Traffic Engineering and Electrical Services
1975; 45p
Research funded by a grant awarded under the Federal Hwy. Safety Program.
Availability: Corporate author

HS-018 310

NEED TO IMPROVE BENEFIT-COST ANALYSES IN SETTING MOTOR VEHICLE SAFETY STANDARDS, NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, DEPARTMENT OF

TRANSPORTATION. REPORT TO THE COMMITTEE ON COMMERCE, UNITED STATES SENATE

A review of the major areas of the auto safety program administered by the National Highway Traffic Safety Administration (NHTSA) is presented. NHTSA's capability for making benefit-cost analyses of motor vehicle safety standards is discussed. NHTSA's estimate of accident costs is compared with the estimates of the National Safety Council and an Office of Science and Technology ad hoc committee. NHTSA's estimating of the effectiveness of proposed safety standards and the cost and production leadtime for these standards are also examined. It was found that: NHTSA uses benefit-cost analyses primarily to establish an order of priority for planning and implementing safety standards; NHTSA measures benefits by estimating how much accidents, fatalities, injuries, and property damage will cost society and by evaluating a standard's effectiveness in reducing such costs; and NHTSA measures compliance costs by estimating the consumer's cost for a safety improvement required by the standard. It is recommended that the Secretary of Transportation: explore with NHTSA ways in which the development of an authoritative accident cause data system might be expedited; and require NHTSA to make an intensive, concerted effort to obtain cost and leadtime data from major domestic and foreign motor vehicle manufacturers on a continuous basis.

Comptroller General of the United States, Washington, D.C.
20548

1974 ; 40p

Availability: Corporate author

HS-018 311

A MODEL OF QUENCH LAYER ENTRAINMENT DURING BLOWDOWN AND EXHAUST OF THE CYLINDER OF AN INTERNAL COMBUSTION ENGINE

An aerodynamic model of the entrainment of the head wall quench layer during blowdown and exhaust of an internal combustion engine has been developed. The model may be used to calculate the time resolved concentration and mass flowrate of hydrocarbons (HC) in the exhaust, from a knowledge of engine geometry and operating conditions. It predicts that the area from which HC are swept will be proportional to the cubed root of the ratio of the quench layer thickness to the thickness of the viscous boundary layer. Since the mass of HC emitted is proportional to the product of the HC density, the area and the thickness, the HC emissions will be proportional to the product of the HC density and the quench layer thickness raised to the 4/3 power. This is the most important factor determining the emissions. The model also predicts that the time dependence of the HC mass flowrate will depend relatively strongly on the pressure ratio across the exhaust valve when it opens: in an unthrottled engine virtually all the head wall HC exit during blowdown; in a heavily throttled engine the HC are emitted more or less uniformly during the exhaust stroke. It is expected that the model will be useful both for interpreting experimental measurements of HC emissions and for predicting HC emissions from practical engines. Comparisons of the results obtained to

date with the available experimental data shows good agreement.

by R. Edwin Hicks; Ronald F. Probst; James C. Keck
Massachusetts Inst. of Tech.
Grant EPA-R800729-04-1
Rept. No. SAE-750477 ; 1975 ; 17p 10refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975. Supported in part by a grant from the Ford Motor Co. and the South African CSIR.
Availability: SAE

HS-018 312

FIELD SERVICE HISTORY ANALYSIS FOR GROUND VEHICLES

The historic development of product design analysis is reviewed to highlight the fundamental needs of collecting and analyzing field service histories for ground vehicles. These needs and other criteria of an analysis procedure which reduce product development time and costs are discussed. It is shown how a three level field service history analysis procedure can fulfill the design analysis needs of product engineers. Histogram forms of field service history analysis and storage and a fatigue life estimation flow chart are provided.

by H. D. Berns
Deere and Co.
Rept. No. SAE-750553 ; 1975 ; 12p 10refs
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 313

SYNTHETIC LUBRICANTS FOR EARTHMOVING EQUIPMENT

Applications of synthetic lubricants to earthmoving equipment are discussed; gear lubrication; hydraulic and torque converter fluid; and engine oils and greases exposed to wide temperature ranges, especially low temperatures. Lubricants that have better low temperature properties and are economical and readily available are closely considered: polyalkylene glycols, synthesized hydrocarbons, ester type lubricants, synthetic hydrocarbon esters, synthetic motor oils, and low temperature multiuse and antiwear synthetic greases. The lower pour points, higher viscosity indexes, and viscosity-temperature extension properties of synthetic lubricants dictate their use in low temperature earthmoving equipment operation.

by William C. Kiefer
Bel-Ray Co., Inc.
Rept. No. SAE-750556 ; 1975 ; 10p 5refs
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 314

OBSERVATIONS CONCERNING ON-SITE BRAKE TESTING OF LARGE MINING TRUCKS IN BRITISH COLUMBIA

The results of over 600 braking tests carried out on large mining trucks are presented. The tests were made over the past

five years at mine sites in British Columbia on dump trucks having load capacities ranging from 35 to 100 tons. All tests were made with the vehicles fully loaded operating on downhill grades ranging from 6% to 10%. Stopping distances were measured from the point of application of the service brakes from various initial speeds. The results are adequate, in some cases, to permit extrapolation of the observed values to indicate a likely "runaway" speed of the truck in the event of failure of the regenerative or other auxiliary retarding system. In many cases, even with excellent maintenance, the stopping distances realized under actual test conditions are far greater than those predicted from calculations based on design brake forces. The tests have shown that this difference may be largely attributed to the following factors: insufficient heat dissipation by some disk brakes; inadequate hydraulic pressures on brake cylinders; inequitable sharing of the total brake load between the front and rear brakes; and incorrect or faulty components and improper installations. In addition to brake test results, guidelines for conducting on-site brake tests are appended.

by V. E. Dawson
British Columbia Dept. of Mines and Petroleum Resources
(Canada)
Rept. No. SAE-750560 ; 1975 ; 35p
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 315

FIRES ON LARGE OFF-ROAD VEHICLES: THE PROBLEM AND SOLUTION

A semi-automatic fire protection system has been developed to reduce operator hazards, the cost of repair, and lost production time as a result of fires on large mobile machines. Causes include: oil or fuel (broken hoses cause some 45% of the total); electrical (faulty or damaged wiring and connectors represent 24% of the total); and mechanical (friction, wear, and brakes resulted in 17% of the total). Research of military and industrial fire protection systems for mobile equipment has resulted in a hybrid prototype system that combines optical and thermal fire sensors, logic controls, self-monitoring circuits and an extinguishing system to meet rigorous demands imposed by off-road equipment. The amount and type of fire protection needed for a variety of equipment is explained and a decision analysis matrix provides guidelines and rating scales of fire protection necessary for large haulage trucks and other off-road equipment.

by Ralph B. Stevens
FMC Corp., Advanced Products Div.
Rept. No. SAE-750561 ; 1975 ; 10p 16refs
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 316

ALARM INDICATING DEVICES [FOR ENGINES]

Results obtained during attempts to gain extended engine life by means of warning and information systems are discussed. Two engine alarm systems, an elementary system which may have had some effect in reducing cylinder head damage and a more complex system which can monitor oil levels and contains fault-detecting circuitry, are described. Data is presented

on cylinder head mortality rates since the introduction of the initial rudimentary alarm system. No claim is made that this system was the cause of the correlated decreasing head mortality rate. Experience gained from problems encountered with the elementary systems has led to an examination of the purposes and limitations of monitoring systems as applied to earth-moving equipment. This in turn has led to the development of a second-generation system which, it is hoped, will overcome some of the deficiencies of the elementary system without introducing major problems of its own.

by H. T. Vidovic; C. B. Murray, Jr.
General Diesel and Equipment, Inc.
Rept. No. SAE-750562 ; 1975 ; 8p
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 317

DESIGN CONCEPTS OF THE JD770 MOTOR GRADER

Some of the major design concepts, features and specifications of the new John Deere JD770 Motor Grader are discussed. Drawings of the engine area, the drive train, the hydraulic system, the manual and electric poppet valves, the locking pin, and the draft frame ball are included. The basic grader reliably performs grading functions with precise, drift-free, hydraulic controls and unlimited blade positioning is achieved entirely from the operator's station. It is easily serviced, since most components are in accessible locations for convenient repair or replacement as a unit or module for expediency of correcting a malfunctioning part. For operator comfort and convenience, the controls require a minimum of effort and are arranged and grouped to reduce unnecessary operator movement. Operator's visibility to machine elements, work area, and job site are maximized by a low narrow enclosure floor, narrow control console, and positioning of the primary ROPS structure behind the operator.

by L. L. Williams
John Deere Dubuque Works
Rept. No. SAE-750564 ; 1975 ; 11p
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 318

SIX-BY-SIX DESERT VEHICLE

The application of one specific six-by-six powershift all-wheel drive vehicle to the desert environment is discussed. Power train component requirements for the "Desert Prince" model J-2065 are detailed for the: engine, converter, transmission, cooling system, and axles. Frame, cab, and tire specifications are also discussed. The cooling system and tires are the major differences in the desert six-by-six, when compared to the conventional all-wheel drive units applied to the United States construction market. Data required to establish cooling system

design, recommended tire leads and inflation pressures, and tire load ratings are provided.

by Dennis T. Crowe, Sr.
Oshkosh Truck Corp.
Rept. No. SAE-750566 ; 1975 ; 11p 5refs
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 319

TRUCKS IN A COLD WEATHER ENVIRONMENT

The steps taken by a truck manufacturer in designing a truck that provides a satisfactory driver environment and performs in an efficient manner under cold weather conditions are outlined. The environmental conditions are identified and the truck design is determined and tested. Implemented design features include: a radiator winter front; thermatic engine fan drive; underhood insulation; extensive cab insulation; insulated heater hose; an ether starting aid; oil pan heater; battery heater; engine coolant heater; electrical junction box; heated fuel tank; air brake system dryer; and heated outside rearview mirror. The test chassis, completely equipped with the described cold weather features, was cold soaked to -40°F and -65°F. The truck started in five seconds in both cases and heat generation and retention were accomplished providing a very satisfactory driver environment. Photographs of the various design modifications are provided.

by Robert D. Jones
International Harvester Co.
Rept. No. SAE-750567 ; 1975 ; 12p
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 320

DEVELOPMENT OF A ONE-PIECE RIM FOR EARTHMOVER TIRES

The off-highway, 15° bead seat tire and its 15° tapered bead seat drop center rim, a new concept for modern earthmoving vehicles, are described. An in-house testing consisting of four segments is discussed: tire mounting trials; hydro-static inflation burst testing; stress determination under load and inflation; and comparison of rim to vehicle mounting methods. Two test tires were built for the testing program: a 38W-53.5/44 ply rated tire with intentionally modified beads to represent the single bead wire bundle and narrow bead found on radial tires; and a 38W-53.5/58 ply rated tire built to represent the worst mounting situation. The in-house testing was conducted in an effort to produce the first production part as a safe, reliable, and durable component of the earthmoving vehicle it is designed to carry.

by Wm. T. Anniss
Firestone Tire and Rubber Co., Electric Wheel Co. Div.
Rept. No. SAE-750572 ; 1975 ; 8p
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 321

TEMPERATURE BUILDUP AND RADIAL SPRING RATE PROPERTIES OF SIX OFF-THE-ROAD TIRES

Temperature buildup tests and load deflection tests have been conducted on six tires, three sizes with one bias, and one radial ply carcass construction per size. The static radial load-deflection relationship and the relationship between pressure, radial load, speed, and temperature were investigated. Values of the spring costs constants, which is the slope of the loading curve at the vehicle gross weight, taken at a point on the loading curve within the recommended load range of the Tire and Rim Association, are presented, tabulated as operating stiffness. An average spring constant value over the deflection range considered, which is dependent on deflection, is also presented. Loss energies occurring during the loading and unloading cycle are tabulated. All tire temperature tests involved testing all tires at initial inflation pressures of 40 pounds per square inch (psi) and 60 psi and at speeds of 25 mph and 50 mph. The intent of these tests was to measure the relative performance of the tires tested near their performance limits. Data are presented on the influence of speed, load, inflation pressure, carcass condition, and tire size on temperature. For each tire, for the same time period, higher temperatures were reached for higher speeds, higher loads, and lower inflation pressure. Also, at the same conditions, the radial carcass tire is cooler than the bias carcass tire. Under roughly equivalent conditions, the larger tires were found to run cooler than the smaller ones. This result may be attributed to the fact that the rate of flexure is less for the larger tires at the same forward speed.

by Ben J. Brookman; Peter Skele
Air Force
Rept. No. SAE-750573 ; 1975 ; 11p
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 322

WORK CAPABILITY FACTORS FOR DOZER AND LOADER TIRES OPERATING IN LOAD AND CARRY SERVICE

A method has been developed for establishing Dozer and Loader tire work capabilities for load and carry service. Controlled tests using a front end loader with a 10 cubic yard bucket as the primary test vehicle were conducted to determine the tire heat build-up characteristics of Dozer and Loader type tires used in load and carry service. Test courses were set up to simulate one way haul lengths of 250, 500, 1,000, and 1,500 feet and the cycles were travelled in both the loaded and empty conditions. Various constructions of three tire sizes, including bias, bias/belted, and radial, and various types and treads were tested. A modified truck was the correlation vehicle used for determining the heat limitations of tire sizes other than those which could fit on the front end loader vehicle. These tests were run under constant load on a continuous cycle test course. Testing at the same average speeds and average load indicated a significant increase in tire temperature for shorter haul lengths than for the longer haul lengths. This increase was most noticeable at haul lengths of less than 500 feet one way. It is concluded that this temperature increase can be attributed to the faster actual speeds required at shorter haul lengths to maintain the same average speed; the higher percentage of overall cycle time required for

above the tire and Krim Association load tables for 5 mph maximum speed; and average vehicle speed must be calculated based on continuous operation. It is concluded that this rating system has been found to be valid and that the system can be utilized in planning a new job or evaluating and modifying an existing one.

by David V. Cvenegros; Richard J. Olsen
Goodyear Tire and Rubber Co.
Rept. No. SAE-750574 ; 1975 ; 8p 5refs
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 323

LUBRICANT CONTAMINANTS AND THEIR EFFECTS ON BEARING PERFORMANCE

Common types of solid and liquid lubricant contaminants are discussed and the different types of premature damage to anti-friction bearings which can result from these contaminants are described. The three ways that harmful contaminants can enter the lubrication system of any type of machinery and cause premature bearing damage are: contaminants introduced during assembly of the mechanism; external contaminants entering the mechanism in service; and contaminants generated internally during operation. Common types of contaminants which find their way into machinery during assembly include: core sand, gear lapping compounds, gear marking compounds, and miscellaneous scrap and debris. Shaft seals and vents are the prime locations where contaminants can enter the equipment during operation. Solid contaminants in lubricants may result in abrasive wear or contact fatigue damage to the bearings. Liquid contaminants may result in chemical wear or contact fatigue. Laboratory rig tests were developed to investigate the effects of contaminant concentration level, particle size, and particle hardness on the bearing damage. Laboratory tests were conducted to investigate the effect of water on the particular lubricant being used and the resultant chemical wear and contact fatigue damage to the bearings. Some case histories of applications with contaminated lubricant problems and the resulting difficulties encountered with bearing performance are reviewed. The evidence supplied by the case histories demonstrates that radical deviation from the normally accepted or baseline contamination conditions is usually required in order for a problem to be recognized.

by Brian Fitzsimmons; Brian J. Cave
Timkin Co.
Rept. No. SAE-750583 ; 1975 ; 12p 8refs
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 324

LINK PIN SEALS ON OFF-HIGHWAY EQUIPMENT

An adaptation of the steel-encased polyurethane rod scraper is now being used to extend the lubrication intervals and the life of critical linkage pins and bushings at oscillating pivot points

rubber. The distinctive properties are hardness without brittleness, load-bearing capacity, plus abrasion, impact, ozone, oil, and grease resistance. While on machines not equipped with link pin seals, average lubrication time every 10 hours requires two mechanics and 45 minutes, the use of link pin seals extends the machine operating hours to 250 on most linkage lubrication points, and in some cases up to 400 hours of services before lubrication is necessary. Link pin seals also contribute to a reduction in squeaks and some protection from rusting in periods of extended down-time. A further benefit of the link pin seal is conservation of lubrication materials.

by R. H. Prachel; I. L. McMillen
Garlock Inc., Mechanical Rubber Div.
Rept. No. SAE-750584 ; 1975 ; 8p 1ref
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 325

THE APPLICATION OF CENTRALIZED LUBRICATION SYSTEMS TO MOBILE EQUIPMENT

Recent developments in centralized lubrication systems have made them more compatible with the operational demands of the construction industry. The centralized lubrication system consists of a proportioning network, pump, control, and monitor. The basic component of the proportioning network is the series feeder. The system is completely sealed and has virtually no external moving parts. The series feeder receives lubricant under pressure and accurately proportions the correct amount to each bearing in the system. If for any reason a bearing becomes blocked, a central high pressure signal can be obtained at the pump, allowing every point in the system to be monitored from one central location. Four possible pumping methods are available for use in central lubrication systems: manual single point; manual hand pump; automatic pumping; and automatic, timer actuated pumping. The proper type and quantity of lubricant delivered to each point at the proper lubrication interval will assure long life for the lubricated parts. The following factors must be considered when designing central lubricating systems for mobile equipment: the geometry of the bearing; the manufacturer's recommended lubrication interval; the movement of the wear surface; and the environment of the lubrication points. Proper installation is probably the most important aspect of a centralized lubrication system on mobile equipment. A good lubrication program results in increased safety for personnel, continuous lubrication, reduced down-time, reduced usage of lubricants, longer machine life, and higher profits.

by Bill Mueller
Ritter Engineering Co.
Rept. No. SAE-750585 ; 1975 ; 8p
Presented at the Earthmoving Industry Conference, Central Illinois Section, Peoria, Ill., 15-16 Apr 1975.
Availability: SAE

HS-018 326

ENERGY CONSERVATION OPTIMIZATION OF THE VEHICLE-FUEL-REFINERY SYSTEM

A study of the relative miles of transportation that can be obtained from a barrel of crude oil by using different types of engines and fuels was conducted. The following options were investigated: the use of leaded gasoline in an internal combustion engine; the use of unleaded gasoline; maximum use of diesel engines; maximum use of the direct injection stratified charged engine; and maximum use of gas turbine engines. The fuel processing losses associated with converting the crude oil to the various specified fuels are also considered in this analysis. Refinery simulation models were developed which would maximize the production of each required fuel type and data were generated for comparing the various modelling runs. The choice of engine type, the fuel required, and the refining necessary to process the fuel has a dominant influence on the petroleum resources and imports required to supplement them in the United States. Data generated on the interrelationships of the vehicle-fuel-refining system shows that the miles of transportation per barrel of crude oil ranges from a low of 316 miles for the use of unleaded gasoline in an internal combustion engine to a high of 440 miles for direct injection stratified charge (DISC) or other engines capable of operation on a 100° to 650°F boiling range distillate fuel without octane or cetane requirement. The DISC option uses less crude oil per day than current domestic crude oil and natural gas liquids production. It is concluded that imported crude oil requirements can be reduced appreciably through the adoption of direct injection stratified charge engines for use on motor vehicles.

by W. T. Tierney; E. M. Johnson; N. R. Crawford
Texaco, Inc.
Rept. No. SAE-750673 ; 1975 ; 29p 27refs
Presented at the Fuels and Lubricants Meeting, Houston,
Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 327

AN HISTORICAL REVIEW OF REDUCTIONS IN FUEL CONSUMPTION OF UNITED STATES AND EUROPEAN ENGINES WITH MOS2

A chronological report of the results of dynamometer, track, fleet, and leased car tests sponsored or conducted during the period 1963 through 1974 and designed to evaluate the effect of the inclusion of molybdenum disulfide (MoS₂) in the engine oil on fuel consumption in gasoline engines is presented. Statistical analysis of the data generated by these tests shows an average improvement in fuel consumption of 4.4% due to a 1.0% weight MoS₂ treatment in the engine oil. The range of values is 2.3 to 6.4% at the 95% confidence level. No adverse effects due to MoS₂ were observed in any of the engine tests. It is suggested that further research using contemporary engines and procedures is needed in order to evaluate the improvements in fuel economy which can be achieved today through the addition of MoS₂ to engine oil.

by T. J. Risdon; D. A. Gresty
Climax Molybdenum Co.
Rept. No. SAE-750674 ; 1975 ; 14p 20refs
Presented at the Fuels and Lubricants Meeting, Houston,
Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 328

LUBRICANT VISCOSITY EFFECTS ON PASSENGER CAR FUEL ECONOMY

The effects of engine and power train lubricant viscosities were investigated in passenger car tests using either high- or low-viscosity lubricants in the engine, automatic transmission, and rear axle. Fuel economy was determined in both constant speed and various driving cycle tests with the full-size test car completely warmed up. In addition, fuel economy was determined in cold-start driving cycle tests. Using low-viscosity lubricants instead of high-viscosity lubricants improved warmed up fuel economy by as much as 5%, depending upon the differences in lubricant viscosity and type of driving. Cold-start fuel economy with low-viscosity lubricants was 5% greater than that with high-viscosity lubricants. With such improvements, it is concluded that significant customer fuel economy gains can be obtained by using the lowest viscosity engine and power train lubricants recommended for service. To determine if currently recommended engine oil, automatic transmission fluid, and rear axle lubricant viscosities can be reduced, extensive performance and durability testing will be required.

by E. D. Davison; M. L. Haviland
General Motors Corp. Res. Labs.
Rept. No. SAE-750675 ; 1975 ; 10p 13refs
Presented at the Fuels and Lubricants Meeting, Houston,
Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 329

LUBRICANT RELATED FUEL SAVINGS IN SHORT TRIP, COLD WEATHER SERVICE

Engine oils, gear lubricants and lubricant sets were compared on fuel economy in cold start, short trip, cold weather service using full-size and compact cars. Significant improvements in fuel economy were shown through lubricant selection. The effects of other variables were identified and ambient temperature effects on fuel economy were quantified. The California 7-mode driving cycle (full specifications are appended) was selected for fuel economy tests in cold weather, short trip service. Average speed for each cycle was 21.8 mph over 8.3 miles for each evaluation. Test vehicles were operated from cold start on a single lane of a road simulator equipped to measure fuel consumption in pounds. The vehicles were manually driven using fan and inertia loading which simulates operation on a level road. It was found that: short trips consume more gasoline due to warm-up factors and driving conditions; selected engine oils and gear lubricants improved fuel economy on the order of 5.0 to 0.9% in cold start, cold weather service for trips of one to eight miles; fuel economy improvements found with sets of selected engine oils and gear lubricants for a four mile trip from a cold start averaged 3.2 and 3.0% for full-size and compact cars; improvements found with selected engine oils or axle lubricants alone ranged from 2.5 to 1.1% for a cold start trip of four miles; lubricant related fuel economy improvements diminished with increasing trip length from one to eight miles; statistical treatment of fuel economy data showed ambient temperature as a highly significant variable in cold start, short trip, cold weather service; and coefficients developed by multiple linear regression analyses reflected a 7.0 and 7.6% increase in fuel economy (full-size and compact cars respectively) in a four mile trip for

a 10°F ambient temperature increase from temperatures in the 33-35°F range.

by Thomas J. Sheahan; W. S. Romig
Lubrizol Corp.
Rept. No. SAE-750676; 1975; 14p 8refs
Presented at the Fuels and Lubricants Meeting, Houston,
Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 330

STABLE COLLOID ADDITIVES FOR ENGINE OILS-- POTENTIAL IMPROVEMENT IN FUEL ECONOMY

A concept of engine oil formation which holds the promise of reducing engine friction and fuel consumption is discussed. It does not require additional petroleum resources. The concept involves the use of several stable colloid lubricant additives as components in multigrade engine oils. A seven car test fleet of 1973 four-door sedans with 400 cubic inch engines was used for 6,000 mile test cycles on each car and engine-oil combination. Each test cycle was repeated five times. Engine dynamometer tests were conducted on a well broken-in 1975, 350 cubic inch engine to determine brake specific fuel consumption, absolute manifold pressure, and hot motoring engine friction using the most promising colloid additive system. After 100 hours of test at 55 mph (road load), fuel consumption was reduced by about 2% and engine friction was inferred to have been reduced by more than 10%. Engine oils treated with these stable colloid additives hold the promise of effecting important fuel savings over the total existing vehicle population within a minimum time frame.

by James E. Bennington; David E. Cole; Peter J. Ghirla; R. Kennedy Smith
University of Michigan; Acheson Industries, Inc.
Rept. No. SAE-750677; 1975; 15p 13refs
Presented at the Fuels and Lubricants Meeting, Houston,
Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 331

CRITICAL STUDY OF THE UNITED STATES EXHAUST EMISSION CERTIFICATION TEST-- ERROR AND PROBABILITY ANALYSIS

A critical study, based on statistical methods, of the United States Exhaust Emission Certification Test is discussed. With the results of this investigation, it is possible to calculate the real risk for passing the Certification Test and to determine the engineering goals (or safety margins) which are required to pass Certification. In addition, systematic errors should be taken into account. Meeting these safety margins represents a calculable additional aggravation of the already stringent standards.

by Martin Fock; Karl-Heinz Lies; Laszlo Pazsitka
Volkswagenwerk AG (Germany)
Rept. No. SAE-750678; 1975; 11p 3refs
Presented at the Fuels and Lubricants Meeting, Houston,
Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 332

CONTROL OF AUTOMOTIVE SULFATE EMISSIONS

A study has been made of potential methods for controlling sulfate (SO₄) emissions from oxidation catalyst-equipped vehicles. The methods considered included operating condition and catalyst changes, as well as the use of a vehicle trap for SO₄. Emissions of SO₄ from non-catalyst cars were also measured. Two 2000 kilogram inertia weight, 1975 vehicles meeting the Federal Interim Emission Standards were used. The first was a 350 cubic inch V-8 equipped with a pelleted oxidation catalyst. It was modified by the addition of an air pump to reduce its carbon monoxide (CO) and hydrocarbon (HC) emissions to about 2.1 grams per kilometer (g/km) and 0.26 g/km respectively. The second was a 350 cubic inch V-8 equipped with an air pump and a monolithic oxidation catalyst which treated half of the exhaust. It was modified by the addition of a second monolith on the other side of the engine, lowering CO and HC emissions to about the same level as the first vehicle. After about 4000 km of aging, the two vehicles were put through a test sequence consisting of: a Federal Test Program (FTP), 20 minutes at idle, 2 hours at 96 km per hour, and a second FTP. Separate integrated readings of sulfur dioxide and SO₄ were made for the first 20 minutes of each half hour period. The only engine operating variable found to significantly lower SO₄ emissions was exhaust gas -oxygen level. Pelleted catalysts emitted lower amounts of SO₄ during low speed operation than did monoliths, but during subsequent high speed operation, their sulfur oxides were driven off, resulting in higher SO₄ emissions from pellets than from monoliths. Catalyst age was found to be an important factor. Pt catalysts gave somewhat higher SO₄ emissions than Pt-Pd catalysts, while concentration of Pt-Pd on the catalyst had no effect in the range studied. Vehicle SO₄ traps containing calcium oxide-based pellets achieved almost complete SO₄ removal from the exhaust for 40,000 km, but pressure drop through the trap became excessive as the sorbent swelled with age. Efforts to lower the pressure drop resulted in poorer SO₄ removal and capacity. More work is needed to improve all three parameters.

by E. L. Holt; K. C. Bachman; W. R. Leppard; E. E. Wigg; J. H. Somers
Exxon Res. and Engineering Co.; Environmental Protection Agency
Rept. No. SAE-750683; 1975; 13p 7refs
Presented at the Fuels and Lubricants Meeting, Houston,
Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 333

URBAN INTERSECTIONS: PROBLEMS IN SHARING SPACE

A study directed at identifying and defining the safety and operational problems related to the interaction of pedestrians and vehicles at urban intersections is reported. Both signalized and non-signalized intersections were investigated covering a wide range of high and low volumes. Over 5,300 pedestrian intersection accident records were analyzed. Four data bases were used; three were from in-depth accident investigation studies, and the fourth contained police accident reports covering a three-year period. More than 25 different urban areas were represented in the sample. Over 75 traffic engineers and safety experts were surveyed to obtain expert opinions on current urban intersection problems and potential

solutions to them. Ten major pedestrian safety problems were identified and 17 potential solutions selected. Several pedestrian and vehicle measures were developed through two field studies at 120 intersections and a series of field observations at 30 matched intersection pairs were directed at identifying site characteristics associated with high accident locations. Over 17,000 pedestrian crossings were observed during the field studies and 16 behavioral measures tested. Literature was reviewed to identify human factors data and concepts relevant to pedestrian and driver safety at intersections. The following problem areas need to be addressed in order to improve intersection safety: turning vehicle/pedestrian conflicts; signalization with regard to timing, display, location and public understanding of operation; visibility at non-signalized intersections; and driver and pedestrian education and training.

by H. Douglas Robertson
 Publ: Traffic Engineering v46 n2 p22-5 (Feb 1976)
 1976 ; 13refs
 Availability: See publication

HS-018 334

A STATISTICAL ANALYSIS OF SEAT BELT EFFECTIVENESS IN 1973-75 MODEL CARS INVOLVED IN TOWAWAY CRASHES: TECHNICAL SUMMARY

A statistical analysis of seat belt effectiveness for about 8,000 towaway accidents involving 1973-75 model passenger cars was made. Information from police reports with subject and witness interviews, hospital information, and investigation of the vehicle were used. National representativeness was strived for by utilizing investigation teams in New York, Michigan, Miami, San Antonio, and Los Angeles. The effects of some of the most important confounding variables are accounted for in the multivariate analyses employed and the corresponding estimates of the precision of the resulting effectiveness measures are derived. Occupants of vehicles in which at least one occupant was transported to a treatment facility were sampled at 100%. Otherwise, the vehicles were selected at a 50% rate using the odd/even status of the license plate terminal digit as the randomizing mechanism. On the basis of the 10,758 available weighted observations for which complete information was available on belt usage and injury level within the various combinations of crash configuration, vehicle damage severity, vehicle weight, and occupant age/seat position, 56.3% of the occupants were unrestrained, 16.9% wore lap belt only and 26.8% wore both lap and shoulder belts. Belt usage by vehicle model year is given. Lap and shoulder belt usage jumped considerably with the 1974 models (from 6.3% to 46.9%) due to the introduction of the ignition interlock system. Restraint usage by injury distribution for the sample is indicated. Crash configuration, vehicle damage severity, vehicle weight, and occupant age/seat position were post-stratified. The distribution for each of these variables is given. The adjusted injury rates for the sample become 12.0%, 9.3%, and 5.1% for unrestrained, lap belted, and lap and shoulder belted occupants, respectively. It is concluded that controlling for vehicle damage is most important with crash configuration next in importance. Controlling for age/seating position has the least effect on the crude effectiveness estimates.

by Donald W. Reinfurt
 University of North Carolina, Hwy. Safety Res. Center,
 Chapel Hill, N.C.
 1975 ; 10p
 Availability: Corporate author

HS-018 335

PSYCHOMOTOR SKILLS RELATED TO DRIVING AFTER INTRAMUSCULAR ADMINISTRATION OF DIAZEPAM AND MEPERIDINE

Psychomotor skills related to driving and the ability to discriminate the fusion of flickering light were measured in a double-blind cross-over fashion in 11 healthy student volunteers (eight men and three women) before, and one, three, five, and seven hours after, intramuscular injection of saline solution, 10 milligrams (mg) diazepam, or 75 mg meperidine. The late effects of meperidine were tested in five other subjects 12 and 24 hours after the injection. The effects of diazepam were the most harmful to coordinative and reactive skills, which were significantly impaired for as long as five hours. Meperidine impaired reactive skills for as long as three hours and flicker-fusion discrimination and coordinative skills for as long as twelve hours. It is concluded that patients should not drive or operate machinery for at least seven hours after receiving 10 mg diazepam intramuscularly and for 24 hours after receiving 75 mg meperidine intramuscularly.

by Kari Korttila; Markku Linnoila
 Publ: Anesthesiology v42 n6 p685-91 (Jun 1975)
 1975 ; 24refs
 Availability: See publication; Kari Korttila, Dept. of Pharmacology, Univ. of Helsinki, Siltavuorenpenger 10 A, SF-00170 Helsinki 17, Finland

HS-018 336

INVESTIGATION INTO USE AND OUTFIT OF SCHOOLCHILDREN'S BICYCLES

The use of safety equipment on bicycles used by schoolchildren in Finland was investigated through the inspection of 606 bicycles and interviews with 400 children and parents. The equipment of the bicycle was divided into three groups: that prescribed by law; other items used rather commonly or that are obligatory under certain conditions; and accessories, such as special handlebars and high back supports provided as luxury items. About 75% of the bicycles had the legally required equipment in good condition and in the proper place. Headlights, which are not obligatory, were lacking in 47% of the observed bicycles. The most popular accessory was found to be high back supports. The survey examined the opinions of children and their parents with regard to bicycle riding. More than 80% of the children surveyed used bicycles on trips to school. Around 50% of the children considered the volume of traffic on their trip to school high. Of the 20% of the children who had been involved in accidents, most were involved in slight accidents occurring during leisure riding. Both children and parents were found to be aware of the inadequacy of bicycle equipment. Of those interviewed, 37% did not consider prescribed equipment sufficient and asked for more obligatory equipment. Dangerous intersections, lack of bicycle paths, high speed of other vehicles, and high traffic volume were mentioned as factors most endangering the safety of child bicyclists. It was concluded that, although children on the whole manage well in traffic with bicycles, increasing the number of separate bicycle routes and restraining the use of bicycles by the youngest age groups would be efficient mea-

ures to improve safety. A copy of the interview questionnaire used in the study is included.

by Pekka Tiainen
Publ: HS-017 940 (Liikenneturva-16) Investigations into Light
Traffic 1, Helsinki, 1975 p1-16
1975
Availability: In HS-017 940

HS-018 337

USE OF WARNING PENNANTS IN BICYCLES

The use of a warning pennant on bicycles was investigated at three locations in Finland in the summer of 1972 in order to determine the effect of the pennant on passing distances under normal traffic conditions. The effect of the warning pennants on traffic behavior was studied both on rural highways and in urban traffic. Two bicycle riders, one of whom had a warning pennant on the bicycle and one of whom did not, rode in turns in the experimental area. The two observers checked the distance at which vehicle drivers passed the bicycles. In highway conditions, 3,508 overtakings were observed, while 2,325 overtakings were observed in urban traffic. Of the observations made in urban conditions, 1,360 were made during daylight hours. The results indicate that vehicle drivers tend to allow more passing room more often for bicycles fitted with a warning pennant than for those without such a device. In the test situation, 40% of the drivers passed the bicycle fitted with a pennant by moving to the center lane, while only 30% moved to the center lane when passing the control bicycle. The effect of the warning pennant is most significant when there is oncoming traffic at the moment of overtaking. When a bicycle without a warning pennant was overtaken in the presence of an oncoming vehicle, almost all vehicles passed and only about 30% of the overtaking vehicles moved to the center line to pass. When a pennant was used, about 13% of vehicles refrained from passing and about 50% moved to the center line. Longer distances were allowed for passing a bicycle equipped with a pennant than for the bicycle without one. The higher the speed of the vehicle the longer the distance at which the bicycle is passed, also. Drivers were found to give slightly more room to a bicycle fitted with a warning pennant than to a bicycle without a pennant, particularly in the dark, in urban areas, although all bicycles were generally passed very closely both in daylight and in the dark in urban areas. The warning pennant was found to have no significant effect on driver behavior in towns. Interviews with 150 vehicle drivers regarding their attitudes toward bicycle riding and to the use of warning pennants showed that almost all drivers felt that the use of the pennant improved the safety of bicycle riders. A copy of the interview form is included.

by Liisa Oranen
Publ: HS-017 940 (Liikenneturva-16) Investigations into Light
Traffic 1, Helsinki, 1975, p17-27
1975
Availability: In HS-017 940

HS-018 338

USE OF SAFETY HELMETS AND GOGGLES BY MOTOR CYCLE AND MOPED RIDERS IN FINLAND IN 1973

Information on the use of safety helmets and goggles by motorcycle and moped riders in Finland was collected by

during the period July 15 through August 15, 1973. Data was collected for about 15,000 motorcycle riders or passengers and for about 6,500 moped riders. Less than 33% of the motorcycles had passengers. More than 70% of the motorcycle riders used a safety helmet, with drivers wearing them in 77% of observed cases and passengers in 55% of observed cases. The use of safety helmets was 10% higher for drivers and 15% higher for passengers riding in rural areas than for those riding in towns. About 58% of the motorcycle riders were using goggles. They were used most by drivers in rural areas (68%) and least by passengers in urban areas (30%). Use of safety helmets by moped drivers was very low (2%), as was the use of goggles (3.5%). Use of safety helmets was more common on weekends than at the beginning of the week. Considerable data on the use of helmets and goggles presented by province, town and rural area, and day of week are included.

by Mikko Korkea-aho
Publ: HS-017 940 (Liikenneturva-16) Investigations into Light
Traffic 1, Helsinki, 1975 p28-38
1975
Availability: In HS-017 940

HS-018 339

DRUGS AND DRIVING. SPECIAL REPORT

The incidence of drug use and driving by licensed drivers, aged 16 to 49 years, in South Carolina is explored. Interviews were conducted with 488 drivers from among visitors to selected highway departments throughout the state. It was found that: 292 (59.8%) drivers had used psychoactive drugs during the previous year and 190 (38.9%) had driven afterwards; 351 (71.9%) had consumed alcohol and 255 (52.3%) had driven afterwards; over-the-counter psychoactives were used with alcohol by 44 (9.0%) and 29 (5.9%) had driven after using the combination; prescription psychoactives were used with alcohol by 42 (8.6%), and 31 (6.4%) had driven afterwards; illicit drugs had been used by 121 (24.8%) during the previous year, and 88 (18.0%) had driven after illicit drug use; and 87 (17.8%) had used an illicit drug with alcohol, and 64 (13.1%) had driven after using that combination. It was projected that: over 274,000 16-49-year-old drivers have driven in the past year after using prescription psychoactives, and over 63,000 have combined prescription drugs with alcohol before driving; and 177,600 have driven after using illicit drugs, and over 129,000 have driven after combining illicit drugs with alcohol. Most of the respondents felt that a large majority of drivers drive at least once a year while they are under the influence of some drug or medicine. Very few drivers knew that the "driving under the influence" law applies to any drugs which impair driving ability. The over-50 age group were more likely to have used prescription drugs and driven afterwards. Recommendations are made for improved detection, prosecution and treatment measures, and for an increase in public information and education. Further research is recommended to verify the findings of this study relative to the general population. A copy of the interview schedule, data tables, and related literature are appended.

by John G. Jaeger; Jennifer Fleming
South Carolina Commission on Alcohol and Drug Abuse,
Alcohol Safety Action Prog.
1975?; 127p 43refs
Supported by the South Carolina Plan Interagency Com. on
Alcohol and Drug Abuse.
Availability: South Carolina Commission on Alcohol and Drug
Abuse, 3700 Forest Drive, Suite 300, P.O. Box 4616,
Columbia, S.C. 29240

HS-018 340

SAFE OPERATION OF AMBULANCES

Although the Standard on Emergency Medical Services, issued by the U.S. Secretary of Transportation in 1967, requires states to have programs and procedures for the safe operation of ambulances and rescue vehicles, it is evident that these requirements, especially with regard to a provision for program evaluation, have not resulted in rigorous efforts or concern on the part of the states to oversee and provide data concerning safe emergency vehicle operations. Although data are incomplete, it appears that emergency vehicles are over-represented in accidents, compared to accidents sustained by the over-all vehicle population. States have not enacted and enforced strong and specific statutes that are commensurate with the need for proper control and surveillance of emergency vehicle operations. There is no convincing evidence that trained, properly equipped ambulance personnel should speed from the scene to the medical facility as a prudent or effective policy for increasing the probability of patient survival; most evidence points to the contrary. Data demonstrates that proper maintenance and safety inspections of the emergency vehicle are definitely needed. Driver training for emergency vehicle operations was found to be not widely applied as a formal and required policy, even though it is a crucial factor for providing safe operation of ambulances. Two way communications in the ambulance and the central command/control of emergency vehicles was found to be a vital element in the safe operation of ambulances, but only about 40% of all ambulances operate under such a configuration. There is a need for each ambulance service to develop and use a manual of procedures and policies regarding operation under emergency conditions.

by Frederick J. Lewis, Jr.
 Pub: Emergency Medical Services v4 n5 p51-2, 54-5, 58-9, 62,
 96 (Sep/Oct 1975)
 1975 ; 3refs
 Availability: See publication

HS-018 341

FUNCTIONAL PROBLEMS OF TELESCOPIC SPECTACLES IN THE DRIVING TASK

Sixteen states have granted licenses for driving motor vehicles to people who can pass the static test of central acuity with telescopic lenses. The telescopic lens spectacle promoted for this purpose (named Bioptic) has a telescope placed in the upper part of the carrier spectacle lens, permitting vision through the spectacle lens by lowering fixation. The telescopic component is brought into use by raising the fixation line through slight flexion of the neck. The principal purpose of the telescopic lens is to pass the driver's static test of acuity and possibly to assist in reading road signs. However, since the wearer does not use the telescope while driving except for distance spotting, he continues for all practical purposes to drive with sub-normal or low vision. Particular problems associated with the use of the Bioptic lens include: a nearness illusion due to increased image size; image movement in the opposite direction of any head movement; difficulty and fatigue in maintaining the head in slight extension as required to see through the spectacle lens portion of the system; difficulty in shifting rapidly from the magnification of the telescope unit to the unmagnified image of the carrier lens; a ring scotoma surrounding the central magnified field which presents a significant hazard, especially when passing other vehicles and at intersections; exaggerated resolution decay by vibration, which

has long been known to reduce acuity even in the absence of magnification; a need to maintain reference points in the small magnified field; and difficulty in trying to use side and rear view mirrors. It is suggested that many of these problems can be at least partially overcome through proper training and practice or by physical compensations

by Arthur H. Keeney; Sidney Weiss; David Silva
 Publ: American Ophthalmological Society Transactions v72
 p132-8 (1974)
 1974 ; 3refs
 Availability: See publication

HS-018 342

STRAIN OF HUMAN BODIES PROTECTED BY SAFETY BELTS IN SIMULATED FRONTAL CRASHES [BELASTBARKEIT GURTGESCHUTZTER MENSCHLICHER KÖRPER BEI SIMULIERTEN FRONTALAUFPRALLE]

The strain on a human body protected by a safety belt during frontal impact accidents at high traffic speeds was tested using a deceleration sled and human cadavers. The experimental sled is decelerated by the conversion of its kinetic energy to the bending stress of sheet metal. Head-on crashes of a passenger protected by a safety belt system were simulated using the following restraint systems: lap-shoulder belt with inertia reel; stress-limiting device and retractor; shoulder belt-knee pad with inertia reel; and shoulder belt-knee belt with stress-limiting device and retractor. Mass-produced seats, mass-produced seats with reinforced spring base, and mass-produced seats with solid bases were used for the tests. The subjects were fresh cadavers of both sexes. The impact velocity, sled deceleration, belt strain, and head velocity at the forehead were recorded in relation to time by a scanning oscillograph and stored simultaneously by a magnetic tape recorder. In addition, the impact phase was filmed from the front and the sides with high speed cameras. Ten experiments were conducted with cadavers in the young, middle, and old age groups at impact velocities of 50 or 80 kilometers per hour against a solid barrier with a mean deceleration of between 18.5 and 31 g. The test results indicated that the chances of survival for a young person wearing a safety belt involved in a frontal impact at an impact velocity of 50 kilometers per hour are good, while the chances of survival for middle-aged and elderly people under the same conditions range from good to bad. To lessen the risk of injury of the cervical or the upper thoracic vertebrae in the various harness systems, the angle of the head would have to be limited to about 80 degrees. Use of taut and wider versions of shoulder belts could prevent the injuries they cause at low speeds and moderate injuries caused at high speeds. Restraint over both shoulders is advisable. To eliminate the injuries caused by the lap belt, the knees should be included in the restraint. No knee-cap, thigh, or pelvic injuries occurred during simulated impacts in which a knee-belt or knee-pad was used.

by D. Kallieris; G. Schmidt
 Rept. No. CSIR-Trans-1196; N75-30779 ; 1974 ; 21p 10refs
 Translated from Z. Rechtsmedizin n74 p31-42 (1974).
 Availability: South African Council for Scientific and Industrial Res., P. O. Box 395, Pretoria, South Africa

HS-018 343

AUTO WEIGHT AND PUBLIC SAFETY. A STATISTICAL STUDY OF TRANSPORTATION HAZARDS

Data from Texas State automobile accident and car registration files for 1973 were used to determine the relationship between auto weight and safety, including the accident frequency, the frequency of getting into an accident resulting in serious or fatal injuries to occupants, the frequency of getting into a serious or fatal accident given that an accident has occurred, and the frequency of accidents involving drunken drivers. Larger cars were found to have a statistically significant higher accident frequency. Given that an accident has occurred, smaller cars appear to have a slightly higher frequency of getting into a serious or fatal accident. Larger cars were found to have a significantly higher frequency of getting into a serious injury or fatal accident. Larger cars were shown to have a much higher frequency of getting into accidents involving drunken drivers. While 67% of the vehicles registered in the state weighed under 4,000 pounds, 60% of the cars involved in accidents and 53% of the cars involved in serious injury or fatal accidents weighed over 4,000 pounds. Over 73% of the accidents involving drunken drivers also involved cars weighing over 4,000 pounds. It is suggested that limitations in obtaining specific relevant and comparable data may lead to some problems with the reliability of the results, but the results are nevertheless significant.

by P. L. Yu; C. Wrather; G. Kozmetsky.
University of Texas, Center for Cybernetic Studies, Austin, Tex. 78712
Contract N00014-75-C-0569
Rept. No. CCS-253; AD-A015 607 ; 1975 ; 29p 6refs
Availability: NTIS

HS-018 344

STATE-OF-THE-ART OF MOTORIST AID SYSTEMS. INTERIM REPORT

The results of questionnaire surveys administered to the responsible government agencies which have or have had motorist aid systems (MAS) and to manufacturers of recent MAS equipment are analyzed. Thirteen states, the District of Columbia, and Puerto Rico operate a total of 45 motorist aid systems, consisting of a total of about 5,200 aid stations. Agencies provided information on the present MAS configuration; the reasons for removing systems if they were terminated and alternatives provided in such cases; recurring costs and systems benefits; experiences, desired changes, and definite problems; and trends in MAS. The four manufacturers provided information on the basic design of the primary product, communications techniques employed, the problems in contracting agencies' expertise, and future trends in MAS communications. Full data on the costs and benefits of motorist aid systems is not available, and many agencies appear to be unconcerned about quantifying the benefits of the systems. Changes which have been made to MAS systems have included providing illumination at aid stations for nighttime use, establishing uniform signing, redesigning field communications facilities, and incorporating all participating agencies in the pre-planning stage. These changes have been in direct response to operational and maintenance problems which have been experienced. Both users and suppliers of MAS systems indicated that current trends are toward voice communications and radio equipment. In-vehicle communications is expected to

replace or complement the present motorist aid systems in the future.

by Gene P. Ritch
Texas A and M Univ., Texas Transportation Inst., College Station, Tex. 77840
Rept. No. RR-165-17; PB-245 036; TTI-2-18-72-165-17 ; 1975 ; 47p 4refs
Report for Sep 1971-Jun 1975. Prepared in cooperation with the Federal Hwy. Administration. Study title: Development of Urban Traffic Management and Control Systems.
Availability: NTIS

HS-018 345

PROTOTYPE FABRICATION AND TESTING OF A MODIFIED MA-2 HARNESS. FINAL REPORT

The use of new low elongation webbing materials in the MA-2 integrated parachute/restraint harness system used by pilots was investigated. The MA-2 harness system is worn by a flight crew member prior to entering the aircraft. The harness contains all the necessary webbing for the parachute and for the lap belt and shoulder harness, needing simply to be attached to fittings in the seat. The webbing materials tested in this study were the low elongation Polyester material and the DuPont Fiber "B" (Kevlar) material, both of which were being developed for use as low elongation seat belt webbing material. Each of these materials was used to replace the nylon webbing in one MA-2 harness. Lap belts, shoulder belts, and inertia reels were also constructed of each of these materials. A complete Polyester system and a complete Kevlar system were then crash tested on a horizontal accelerator and in drop tests. A 50th percentile Sierra dummy weighing about 164 pounds was used in the horizontal tests, while a 95th percentile dummy was used in the drop tests. The test data showed no clearly superior webbing configuration. Unanticipated problems with stitching and weave pattern with the Kevlar and Polyester webbings appear to be the cause of these results. These problems negated the effects of the low webbing elongation. Manufacturers of the materials have indicated that these problems can be overcome, but further research is required to demonstrate the usefulness of these materials in improving crew survival in crash situations. It also appears that the MA-2 harness in itself does not allow for taking advantage of improved webbing materials, and that significant redesign of the MA-2 system may be necessary if the material substitutions are to make any significant difference in improvement of the harness functioning. Photographs of the test set-ups and graphs of acceleration data are provided.

by M. Pavlick; M. Schwartz; J. O'Rourke
Budd Co.; Naval Air Devel. Center, Warminster, Pa. 18974
Contract N62269-74-C-0007
Rept. No. NADC-75034-40; AD-A013 640 ; 1975 ; 57p
Availability: Naval Air Systems Command, Washington, D. C. 20361

HS-018 346

ARMY EXPERIENCE WITH SYNTHETIC ENGINE OILS IN MIXED FLEET ARCTIC SERVICE

A three-phase program was conducted by the U.S. Army in order to obtain basic data required for the development of a new arctic engine oil (OEA) specification to replace the obsolete MIL-L-10295 sub-zero engine oil (OES) specification. The first phase of the program involved the development and

initial testing of improved synthetic engine oils formulated using synthetic hydrocarbon or ester base stock materials. Initial laboratory and qualification type engine testing demonstrated that all of the experimental oils showed significant improvement over currently qualified MIL-L-10295 oils. However, no direct relationship between these tests and field performance could be drawn. Field testing was then conducted for the following purposes: to establish whether or not the experimental lubricants would provide lubrication protection under field operation in the high-output engines known to fail using currently qualified lubricants; to demonstrate the new oil's ability to adequately lubricate a wide range of vehicle engines and components; and to generate performance data required to establish laboratory engine-oil test severity limits and lubricant performance criteria. Laboratory test procedures and performance criteria relevant to the field test results were then developed. Experience has shown that the new synthetic lubricants are superior to the former mineral based oils in ground-powered equipment and that they also function well as year-round hydraulic and power transmission lubricants. Full test specifications, conditions, and results are appended.

by S. J. Lestz; T. C. Bowen
Army Fuels and Lubricants Res. Lab.; Army Mobility
Equipment Res. and Devel. Center
Rept. No. SAE-750685 ; 1975 ; 25p 32refs
Presented at the Fuels and Lubricants Meeting, Houston,
Tex., 3-5 Jun 1975. Prepared in cooperation with Army Alaska,
Army Arctic Test Center, Army Text and Evaluation
Command, Army Tank Automotive Command, Army
Aberdeen Res. and Devel. Center, Army Yuma Proving
Ground, Army Mobility Res. and Devel. Center, and Detroit
Diesel Allison Div. of GMC.
Availability: SAE

HS-018 347

A PSYCHOPHYSIOLOGICAL EVALUATION OF DEVICES FOR PREVENTING LANE DRIFT AND RUN-OFF-ROAD ACCIDENTS. FINAL REPORT

Accident data indicate that drowsiness plays a substantial role in single-vehicle run-off-road accidents. The use of shoulder rumble strips to alert a drowsy driver of departure from the roadway was investigated. Three types of shoulder rumble strips were tested: a rib treatment, consisting of parallel raised strips of rock aggregate set in bituminous binder; a marker treatment, consisting of parallel arrays of raised circular pavement markers; and a groove treatment, consisting of parallel slots cut into the shoulder surface. All treatments were designed to alert drowsy or sleeping drivers by creating noise and vibration within vehicles during inadvertent departures from the travelled roadway. Between 10 and 15 young male drivers were recruited as subjects in separate groups to make repeated trips over each of three separate highway circuits containing sections with one of the shoulder treatments. The subjects drove an instrumented van over the test circuits for up to five hours. The subjects were monitored as to heart rate, electrocardiogram, electroencephalogram, skin conductance, and overall performance. The test results showed that most of the subjects were incapable of operating the vehicle continuously for five hours without a progressive, and, at times, severe loss of driving proficiency. The most obvious sign of that loss was a progressive increase in the tendency to drift out of the prescribed traffic lane, both to the right onto the shoulder and to the left into the adjacent lane. Impacts with the rib treatment produced the greatest arousal; those with a marker treatment also elicited a substantial rise in

arousal than that measured during spontaneous recoveries from shoulder excursions without impacts. The persistence of the immediate physiological arousal reaction was very limited, lasting for no longer than about five minutes, regardless of the type of shoulder excursion. Average angle of departure from the travelled way was about three degrees.

by James F. O'Hanlon; Gene R. Kelley
Human Factors Res., Inc., Santa Barbara Res. Park, 6780
Cortona Drive, Goleta, Calif. 93017
Contract HPR-PR-1(11)-B0153
Rept. No. PB-241-857 ; 1974 ; 115p 12refs
Sponsored by the California Dept. of Transportation. Prepared
in cooperation with the Federal Hwy. Administration.
Availability: NTIS

HS-018 348

CAR CHARACTERISTICS: THEIR CONTRIBUTION TO ACCIDENT RISK

The relationship between the handling characteristics of cars and their accident frequency rates was investigated. Deficiencies in handling are likely to be associated with accidents involving loss of control. Results of an earlier detailed study indicated that over 80% of loss of control accidents involve single vehicles only, so that the single vehicle accident rate should measure proneness to loss of control. Single vehicle accident rates are calculated for various models of cars using the 1969 and 1970 accident data for Great Britain together with the results of a mileage survey undertaken to determine the total annual mileage travelled by each model of car. Analysis of the statistics shows that although accident frequency is strongly related to vehicle mileage, the variation in the number of accidents between different models of cars is not completely explained by the variation in their mileage. Between 70 and 80% of the difference in accident rate between models can be explained by variations in the age and sex of the driver population driving each model. The remaining differences can to a large extent be explained by differences in car characteristics. The results of regression analysis suggest that if driver effects are removed from the accident rate, then handling parameters explain about 35 to 40% of the remaining variation between models of cars. The important parameters appear to be weight, some measure of the change in understeer as a function of lateral acceleration, and power to weight ratio, although the variation explained by the last two parameters is quite small.

by I. S. Jones
University Coll. London
Rept. No. Paper-A106 ; 1974 ; 45p 19refs
Presented at the Australian Road Res. Board Conference (7th)
Adelaide, 1974. Sponsored by the Science Res. Council.
Availability: Reference copy only

HS-018 349

STATE OF THE ART. ANALYSIS AND INTERPRETATION OF STEADY-STATE AND TRANSIENT VEHICLE RESPONSE MEASUREMENTS

The open loop response of road vehicles to steering inputs is described. The literature is reviewed for both steady-state and transient response behavior. It has been established that, for a given vehicle, steady-state response is only basically a function of lateral acceleration. The various measures available for steady-state response covering the whole range of lateral ac-

celeration are discussed in detail and sample measured data are included. Review of the literature shows that the important quantities are the effective cornering stiffness of the front and rear tires, how they are related, and how they vary with lateral acceleration. Transient response is only considered for the region of linear behavior, where it is seen that a control theory approach is appropriate. A sample set of frequency response curves and step input responses is presented. It is concluded that appropriate methods are available for the measurement and description of vehicle-steady-state response over the whole range of lateral accelerations and for transient response over the range of linear behavior. However, applications of desirable levels to these measures is difficult and must depend on the definition of desirable. Although there is some evidence to link some general guidelines, based on driver appreciation and engineering excellence, with performance at specific tasks, there is no hard evidence to link them directly with safety.

by N. F. Barter

Rept. No. MVMA/ENG-8060 ; 1975 ; 35p 63refs

Prepared for presentation at the IUTAM Symposium on the Dynamics of Vehicles on Roads and Railway Tracks, Delft, Netherlands, 18-22 Aug 1975.

Availability: Reference copy only

HS-018 350

TRUCK TRANSPORTATION EFFICIENCY. FINAL REPORT

A mathematical model for evaluating efficiency in the truck transportation industry has been developed. This model is designed to allow for the joint determination of pricing and service quality in trucking and to examine some of the consequences of regulation within this framework. Both the shipper's production function and the delivery speed of the trucking system are allowed to be stochastic. The delivery speed of the trucking system depends on how many customers on average are waiting for service and the capacity of the system, which depends on the inventory of trucks available, the distribution of shipping points to be served, and the average speed of a round trip. The model is set up and solved for a steady-state equilibrium using queueing theory. This solution then gives expected delivery time for the shipper's product as a function of the arrival process at his order desk, his productive capacity, and the rate of capacity utilization of the trucking industry. Shipper's inventory holding costs and rate of utilization of capacity are shown to be dependent on the level of excess capacity in the trucking industry. The essence of the model of the trucking firm and the industry in a competitive market is competition among truckers on the basis of price and shipping time. This model shows that a competitive trucking industry would practice a form of value-of-service pricing. It is suggested that these models indicate that removal of current regulations would raise prices to low traffic intensity areas, but would also markedly improve service quality. An unregulated trucking industry could be expected to have about the same waiting time across markets, but would have varying transport charges, while the regulated industry has about the same transport charges, but widely different service quality. At present, the overall level of capacity provided by the trucking industry is a function of the regulated rate.

by Arthur De Vany; Thomas R. Saving

Contract ASD/TRS 7501-C6.12

1975 ; 97p 12refs

Sponsored by Motor Vehicle Manufacturers Assoc.

Availability: Reference copy only

HS-018 351

MEASUREMENT PARAMETERS FOR AUTOMOBILE IGNITION NOISE. FINAL REPORT

Peak-detector measurements of radiated electromagnetic noise from automobile ignition systems reveal detectable frequency components over a range of 7 gigaHertz. Occasionally a very noisy vehicle will radiate noise over the entire frequency range in excess of 30 decibels above the medium observed noisy vehicle. Subjective evaluations indicate that the land-mobile radio service may possibly be affected by automobile ignition noise. Automobile ignition noise is typically measured using a radio noise meter equipped with either a peak detector or a quasi-peak detector, and has also been measured using special equipment to produce the average weight of occurrence and strength of noise impulses. The result of the latter measurement is referred to as a noise amplitude distribution (NAD). Since the NAD method includes a measurement of the time variations of the ignition noise process, it is superior to the first-order amplitude measurements obtained by the peak or quasi-peak method for modeling the effects of ignition noise on communication systems. Ideal and practical modeling methods are discussed for determining the effect of ignition noise upon communication systems, with emphasis on voice communications.

by Richard A. Shepherd; James C. Gaddie; Aki Shohara

Stanford Res. Inst., 333 Ravenswood Ave., Menlo Park, Calif. 94025

Contract MVMA-SRI-7502-C2.10

Rept. No. PB-247 766 ; 1975 ; 132p 82refs

Sponsored by Motor Vehicle Manufacturers Assoc.

Availability: NTIS

HS-018 352

CRASH CUSHIONS. SELECTION, CRITERIA, AND DESIGN

The Federal Highway Administration (FHWA) of the U.S. Department of Transportation is in the process of approving vehicle crash cushion designs with a 12 gravities of acceleration (g) maximum average deceleration of a vehicle during the time of the impact event. Crash cushion systems which have been approved so far include: steel drums with cable guides and side panels; "Hi-Dro Cell Sandwich", which consists of liquid filled cells with cable guides and side panels; "Hi-Dro Cell Cluster", which consists of liquid filled cells without cable guides or side panels; "Hi-Dri Cell Sandwich", which consists of vermiculite concrete cells with cable guides and side panels; and "Fitch Inertial Barrier System", which utilizes freestanding sand-filled plastic containers. Site conditions, available technology, and costs must be considered in determining the performance criteria appropriate for a particular crash cushion installation. An important factor in determining the cost of a crash cushion installation is its maintenance cost, including restitution cost and ease of installation. The state-of-the-art relative to the dynamic relationship between the crash cushion, the vehicle, and its occupants has not yet progressed to the point that accurate predictions and/or best solutions can be made with any degree of performance reliability. The following site information is needed in order to choose a crash cushion design: physical dimensions of the object to be shielded; structural details of the object to be shielded; physical dimensions of the space available for installation of the crash cushion; and physical conditions of the space available for the crash cushion. Crash cushion choice considerations in-

clude: maximum impact speed; allowable g force; redirection or fendering characteristics; weight/velocity sensitivity; back-up structure; anchorage requirements; flying debris characteristics; vulnerability to nuisance hits; damage to vehicle; esthetic appeal; initial cost; susceptibility to vandalism; routine maintenance; and restitution maintenance. Design and construction information on the approved crash cushion systems is included. Design drawings are also provided.

by L. R. Lawrence; James H. Hatton, Jr.
Federal Hwy. Administration
1975 ; 103p
Availability: Corporate author

HS-018 353

TECHNOLOGY SHARING. A GUIDE TO ASSISTANCE IN OBTAINING AND USING RESEARCH, DEVELOPMENT AND DEMONSTRATION OUTPUTS

Summary information on the programs and mechanisms which are available for obtaining information or assistance on U.S. Department of Transportation (DOT) research, development, and demonstration (RD&D) activities and results are presented. The major emphasis is placed on mechanisms for sharing technological developments relevant to the transportation needs throughout the country with state and local governments. Organizations that DOT provides technical assistance to at the state/local level include: state highway departments; state, regional, and local planning organizations; and transportation operators. DOT's technology sharing and technical assistance activities serve to: communicate with state and local governments and private industry and universities regarding their technology information needs; accomplish the sharing of technology through such activities as demonstration projects, information dissemination and technical assistance programs, and state and local oriented RD&D programs; and facilitate the use of technology and information to develop programs, plans, and policies at the state and local levels. The following organizations within DOT conduct technology sharing and transfer programs in the field of transportation: the Office of the Secretary; the Federal Highway Administration; the Urban Mass Transportation Administration; the Federal Aviation Administration; the Federal Railroad Administration; the National Highway Traffic Safety Administration; the U.S. Coast Guard; the Materials Transportation Board; and the St. Lawrence Seaway Development Corporation. Information on the most prominent programs operated by each of these organizations with regard to RD&D activities and the types of materials available from each organization is provided. A list of contact persons in other agencies which have programs in the transportation area or which are impacting on the quality or transportation service is provided.

Department of Transportation, Washington, D.C.
1976 ; 74p refs
Availability: Corporate author

HS-018 354

AN INVESTIGATION OF TRAFFIC BEHAVIOR AT SIGNALS WITH RED, YELLOW AND GREEN ARROWS. FINAL REPORT

Traffic behavior at a traffic signal with red, yellow, and green arrow right turn controls was studied. A single lens right turn

green arrow signal face at a high volume intersection on a main arterial urban street in Washington, D. C., was replaced with a separate signal face with three lenses showing sequentially a green arrow, a yellow arrow, and a red arrow. Initial response to the three arrow signal was unacceptable, with 20% of all turns being made against a red arrow and with violations occurring in as much as 80% of all the signal cycles during a one-hour sampling period. Some improvement in observance was obtained by installing an explanatory sign alongside the curb lane at the approach STOP line. A major improvement resulted from repositioning the signal head so as to provide a horizontal physical separation of about 2 feet between the signal head controlling the turn and the signal head for the through traffic and from labelling of the signal head as a "Right Turn Signal". The final sign and signal approach includes the following signs in the indicated order: first, THIS LANE MUST TURN RIGHT; second, RIGHT TURN ON GREEN ARROW ONLY; and lastly, NO TURN ON RED ARROW. With these changes, the 3 hour average level of violations dropped to the lowest point observed during the entire period of the study. However, the percentage of violations was still high, with between 7 and 8% of all turns being made against a red arrow indication. Violations occurred during about one-third of all signal cycles, even under the best conditions. It is concluded that verbal messages seem to be critically important, in spite of directional arrows, and that advance warnings of directional arrows for turns improves performance. It is also suggested that extensive publicity be given to the installation of such arrow turning movement control signals, especially when several are to be installed in a given community. It appears that many motorists will violate turning arrow indicators if no serious vehicular conflict is obvious. Photographs of the test site are provided.

by Merwyn A. Kraft; C. Thomas VanVechten
District of Columbia Dept. of Highways and Traffic, Traffic Res. Section, District Bldg., 415 12th St., N.W., Washington, D.C. 20004
Contract HPR-1-626
1973 ; 51p refs
Availability: Corporate author

HS-018 355

AN ASSESSMENT OF PENNSYLVANIA'S PERIODIC MOTOR VEHICLE INSPECTION SYSTEM

A field experiment was performed in an attempt to determine how well Pennsylvania's vehicle inspection system actually operates. Certain defects were installed on a car in components that fall within Pennsylvania state inspection requirements and appointments, seemingly those of a common motorist, were made for the car to be inspected at 20 inspection stations in Pittsburgh. Many discrepancies were found between stations, both in the manner in which the inspection was carried out and in the estimate of repairs required to pass the car. The need for greater enforcement of inspection requirements by the state was indicated. An analysis was performed to discover if component outage data correlated with the requirements of Pennsylvania's system. It was concluded that the maximum obtainable effectiveness of Pennsylvania's current system in detecting outages that can lead to failures is only 75%. By relating inspection requirements to outage and accident causation data, the system's effectiveness in reducing accidents could be improved, as could its cost-effectiveness. Some recommendations are made in the report for improving data collection, as a means of evaluating and improving the system. A number of alternative forms of inspection were con-

sidered: no inspection, annual periodic inspection, and random, spot inspection. Data from other states build a strong case for a random inspection system, in which 10% to 12% of all cars are inspected each year. Drivers would be forced to be more constantly aware of the condition of their cars. It is suggested that inspection concentrate on older cars because they are more likely to suffer certain component outages. A number of specific inspection alternatives are examined using a benefit-cost framework.

Carnegie-Mellon Univ., Program in Engineering and Public Affairs, Pittsburgh, Pa. 15213
1975 ; 171p refs
Availability: I. Barbara Lydon, Program in Engineering and Public Affairs, 2307 Science Hall, Carnegie-Mellon Univ., Pittsburgh, Pa. 15213 \$7.50

HS-018 356

ANALYSIS OF FATAL TRAFFIC CRASHES IN CANADA, 1973: FOCUS: THE [ALCOHOL] IMPAIRED DRIVER

A statistical examination of the involvement of alcohol in fatal traffic accidents in Canada in 1973 is presented. The scarcity of research resources and the magnitude of sampling carried out contributed to making it an aggregate level analysis of the 1725 driver fatalities age 16 and over occurring within British Columbia, Alberta, Manitoba, Ontario, and New Brunswick. Major findings include: males are heavily over-represented in driver fatalities, accounting for 89% of all driver fatalities age 16 and over; young male drivers account for almost 20% of all fatalities; at least 38% of all fatally injured drivers age 16 and over were legally impaired; in considering driver fatalities occurring within six hours of the crash, British Columbia and Ontario reflected the lowest percent of driver fatalities impaired, 42%, and Manitoba, the highest, 49%; multiple vehicle collisions accounted for 57% of all driver fatalities, single vehicle collisions for 43%; at least 27% of all multiple vehicle collision driver fatalities were legally impaired, and 53% of all single vehicle ones were; and older drivers were found to be heavily over-represented within the multiple vehicle collision fatality population. It was also found that: the percent of driver fatalities impaired increased steadily with each successive age category until age 34; 37% (estimated) of all passenger fatalities occurred as a result of an impaired-driver collision; 16-24-year-old passengers were heavily over-represented in passenger fatalities in single vehicle collisions and those passengers 0-15 and 55 and over were over-represented in multiple vehicle collision passenger fatalities; and at least 59% of all pedestrian fatalities age 25 to 34 were legally impaired.

Traffic Injury Res. Foundation of Canada, 1765 St. Laurent Blvd., Ottawa, Ont., Canada
1975 ; 126p 9refs
Availability: Corporate author

HS-018 358

NATURALISTIC STUDIES OF AGGRESSIVE BEHAVIOR: AGGRESSIVE STIMULI, VICTIM VISIBILITY, AND HORN HONKING

Three studies are presented which extend laboratory research on aggression to a naturalistic setting which involved horn honking from drivers as a measure of aggression. The studies were adapted from previous work. In Study One, the results

of a survey of 53 drivers (26 males and 27 females) suggested that they were frequently irritated by and aggressive toward other drivers. Study Two, using a three by two factorial design with 92 male drivers, indicated that manipulations of a rifle in an aggressive context and victim visibility (dehumanization) both significantly influenced horn honking rates subsequent to obstruction at a signal light. Study Three with 137 male drivers and 63 female drivers examined the interactive effects of a rifle, an aggressively connotated bumper sticker, and individual subject characteristics (sex and an exploratory index of self-perceived status) on horn honking. The results for the three studies in naturalistic settings show possible correlations with laboratory based findings on aggression. The role of inhibitions in modifying the pattern of results was also noted, especially in the case of females or old-model automobile drivers versus new model truck with gun rack, and possible interpretations for this behavior are given.

by Charles W. Turner; John F. Layton; Lynn Stanley Simons
Publ. Journal of Personality and Social Psychology v31 n6
p1098-107 (Jun 1975)
1975 ; 24refs
Partly supported by University of Utah Res. Com. Funds 1745.
Availability: See publication; Charles W. Turner, Dept. of Psychology, University of Utah, Salt Lake City, Utah 84112

HS-018 359

ACCIDENTS ASSOCIATED WITH HIGHWAY BRIDGES

An analysis of 1972-1973 accident records for the state of Kentucky with respect to those accidents which involved bridges and surrounding appurtenances is presented. The objective of the study was to identify those principal features of bridges which may be related to accident frequency and severity and to provide some additional insights toward highway safety. Accident data from interstate and parkway (toll) routes and from primary and secondary systems were compiled and summarized. The major findings were the following: bridge-related accidents, particularly severe accidents, were significant percentages of the total accident experience on interstates and parkways; there were fewer bridges per mile on primary and secondary highway systems and a lower percentage of bridge-related accidents than on interstates and parkways; and the severity of bridge-related accidents was higher than the severity of all accidents. It was also found that: the severity of bridge-related accidents on primary and secondary highways was almost identical to the bridge-related accidents on the interstate and parkway systems; collisions with entrance posts resulted in more fatal accidents than other accidents involving bridge structures; and the guardrails at bridge piers have proven less than totally effective. Since a very limited number of accidents involved earth mounds, further development of the mounds, in lieu of guardrails, is possibly warranted. It is further concluded that: the benefit of full-width shoulders is appreciable; openings between parallel bridges on divided highways can create a recognized hazard; a high percentage of nighttime accidents suggests a problem with visibility of the structure; an exceptionally high percentage of accidents occurred during snowy or icy conditions; one-lane bridges on secondary systems constitute a hazard; on primary and secondary highways, several fatal accidents occurred at bridges with curved approaches; and bridge railings were inadequate on some of the bridges on primary and secondary

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highways. Pictures of some of the most dangerous conditions are included.

by Kenneth R. Agent
Kentucky Bureau of Highways, Div. of Res., 533 South
Limestone, Lexington, Ky. 40508
Contract KYP-72-40
Rept. No. RR-427; 1975; 29p 11refs
Availability: Corporate author

HS-018 360

AUTOMOTIVE ELECTRONICS AND DRIVER PHYSIOLOGY

The growth of electronic technology and the development of automotive systems are briefly discussed and the areas where major progress must be made before integrated electronic systems can be considered potential automotive products are outlined. The discussion is in a speech format to be accompanied by slides.

by Trevor O. Jones
G. M. Proving Grounds
1976; 9p
[Paper presented at] Detroit Medical Club, 18 Mar 1976.
Availability: General Motors Corp., Environmental Activities
Staff, Warren, Mich.

HS-018 361

SIMPLIFIED AUTOMOBILE STEERING DYNAMICS FOR DRIVER CONTROL

Simplified equations which provide an adequate approximation of the range of possible vehicle motions, with attention focussed on constant speed tasks which do not demand near-limit performance of the car and with the car assumed to be very stiff in roll, are developed from a more complex mathematical description of the vehicle. The development of these simple equations leads to transfer functions which can be used in conjunction with driver describing functions to study the driver/vehicle system. The equations can also be used to serve as models for vehicle dynamic identification activities. A key simplifying approximation is used to make the varieties of heading and path control dynamics which correspond to oversteer, neutral steer, and understeer configurations particularly conspicuous. The rolling and yawing motions of an automobile in response to steer and angle and side load aerodynamic disturbances are defined. Equations of motion and transfer functions which are adequate for small perturbation motions about steady lateral acceleration levels are presented and discussed. The dependence of the steering response dynamics on dimensional and inertial parameters, tire properties, and forward speed is obtained by expanding the stability derivatives in terms of quantities which define these detailed vehicle properties.

by D. T. McRuer
Systems Technology, Inc., 13766 South Hawthorne Blvd.,
Hawthorne, Calif. 90250
Rept. No. Paper-165; 1975; 30p 11refs
Prepared for the Society of Automotive Engineers Aerospace
Control and Guidance Systems Com. Meeting (35th) Palo Alto,
Calif., 19-21 Mar 1975.
Availability: Corporate author

HS-L 70

HS-018 362

EFFECTS OF AUTOMOBILE STEERING CHARACTERISTICS ON DRIVER/VEHICLE SYSTEM PERFORMANCE IN DISCRETE MANEUVERS

A series of discrete maneuver tasks were used to evaluate the effects of steering gain and directional mode dynamic parameters on driver/vehicle responses. The importance and range of these parameters were evaluated through changes in subjective driver ratings and performance measures obtained from transient maneuvers such as a double lane change, an emergency lane change, and an unexpected obstacle. In the experimental series, the double lane change was made at between 30 and 50 mph, and the driver was able to behave in a dual-manner fashion in the control actions; the emergency lane change was conducted at 30 mph, and the driver was faced with an unknown lane selection situation dictated by the switching of green-red traffic lights; and the unexpected obstacle avoidance maneuver required the driver to take evasive action to avoid an obstacle appearing from the side of the road. The double lane change was the maneuver most sensitive to vehicle dynamic differences, since it was run at higher speed with given differences in vehicle oversteer and understeer properties appear more distinctly than at low speeds. The unexpected obstacle maneuver proved to be more sensitive to individual driver differences than to vehicle differences. The test results were based on full-scale tests with an experienced test driver evaluating many different dynamic configurations plus seventeen ordinary drivers evaluating six key configurations. It was concluded that the key vehicle parameters, in order of importance, are: steering gain, yaw velocity numerical directional frequency, and the directional damping ratio.

by Richard H. Klein; Duane T. McRuer
Systems Technology, Inc., 13766 South Hawthorne Blvd.,
Hawthorne, Calif. 90250
Contract HS-359-3-762
Rept. No. Paper-172; 1975; 15p 13refs
Presented at the Annual Conference on Manual Control (11th)
NASA Ames Res. Center, 21-23 May 1975.
Availability: Corporate author

HS-018 363

THE EFFECT OF STREET LIGHTING REDUCTIONS ON ACCIDENTS

Investigations into the effect on accidents of street lighting reductions made during the energy crisis of 1973/74 are reported. The method of statistical analysis is described and results presented separately for pedestrian and total accidents in addition to the overall totals. The implications of findings are discussed, with special reference to accidents involving pedestrians and those on major roads. An estimate is made of the costs implied by the changed pattern of accidents. In most of the analysis only three London boroughs with associated control groups of boroughs were used. In the analysis of fatal accidents all 20 London boroughs were used and it was found that: the proportion of nighttime accidents fell on the fully lit roads from 1973 to 1974 whereas in the same period the proportion rose on the partly-lit roads but these changes were not statistically significant; there was a significant increase in the proportion of nighttime pedestrian accidents on both types of roads; there was a significant shift

only about 10% of the overall road network. It was estimated that, should the lighting restrictions be prolonged for a complete year, an extra 900 pedestrian accidents and 65 fatal accidents could be expected, there would be an increase in the proportion of serious pedestrian injuries, and the cost of these accidents would be 2.4-3.2 million pounds if accidents without injuries were included.

by M. F. Talbot
Greater London Council, Traffic Operations Div., England
Rept. No. RM-459; 1975; 44p
Availability: Greater London Council Bookshop, County Hall,
London SE1 7PB, England

HS-018 364

NEW YORK STATE POLICE EVALUATION. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION ALCOHOL SCREENING DEVICE

The field testing of Alcohol Screening Devices (ASD's) developed and furnished by the National Highway Traffic Safety Administration to the New York State Police is described. A total of 387 individuals were tested using ASD units at four locations in New York State (Loudonville, East Greenbush, Saratoga, and Brunswick) between May 1974 and October 1974 to determine: the effectiveness of the device in reducing the blood alcohol content of persons arrested for driving while intoxicated (DWI); any increase in DWI enforcement by personnel using the device; the reliability of the device as compared to the Breathalyzer in determining intoxication; the percent and instances of device failure; and the number of "false positive" readings developed by the device compared to the total tests given. Raw data from the field testing tends to show that the ASD is a competent instrument for the measurement of blood alcohol percent in the breath but its lack of complete reliability encouraged the enforcement personnel to use other devices. Equipment construction and ease of use on a constant basis dictates the success of a field operation. Involved personnel did indicate an interest in testing an improved model of an ASD-like device.

by Salvatore Belardo; James Zink
New York State Police
1975; 43p
Availability: Corporate author

HS-018 365

AN EVALUATION OF TWO GROUP INTERVIEW AND TWO LETTER-CONTACT DRIVER IMPROVEMENT PROGRAMS

The effectiveness of two Department of Motor Vehicles' Driver Improvement group interview programs and two letter contact programs, relative to a no-contact driver group, on subsequent driver performance, was investigated. Each of the following treatment conditions was administered to a different, randomly selected group of Washington state drivers who had recently accumulated citation and/or accident entries on their driving records sufficient in number and severity to meet the established selection criteria for admittance to the Driver Improvement Division's First Group Interview Program: the standard First Group Interview, including a meeting between a Driver Improvement Analyst and a group of 10 to 12 traffic offenders and an emphasis on the threat of receiving further punitive actions for continued poor performance (292 drivers);

a modified First Group Interview, minimizing the threats and not informing attendees of their placement under 6-month surveillance (369 drivers); a first class letter advising placement under surveillance and intention to take further action for additional citations during this period (189 drivers); the same letter sent by certified mail (193 drivers); and non-treatment control (195 drivers). The effectiveness of the five treatment conditions was assessed by testing for the statistical significance of group differences for each of the following: the proportions of drivers who accumulated record entries following treatment; the average time lapse between treatment and the occurrence date of a subsequent record entry; and the changes in performance between 12 months prior to treatment selection and the 12 months following treatment. In each of these three measurements, citations and accidents were considered separately. None of the treatment programs significantly reduced the proportions of citations or accidents in the year following treatment below that manifested by the control group, nor did any program significantly extend the length of time between treatment and the receipt of the first post-treatment citation or accident involvement beyond that shown by the control group. Each of the five driver groups accumulated significantly fewer citations in the post-treatment year relative to the pre-selection year, and the interview groups and the no-contact control group demonstrated significant reductions in their frequencies of accident involvement from the pre-selection to the post-treatment years.

by Peggy Ann O'Neill
Department of Motor Vehicles, Res. and Technology Div.,
Olympia, Wash. 98504
Rept. No. 037; 1975; 79p 5refs
Availability: Corporate author, \$2.00

HS-018 366

HIGHWAY ACCIDENT REPORT. JESUS AYALA SCHOOLBUS-TYPE BUS RUN-OFF ROADWAY/DRAINAGE DITCH SUBMERGENCE. BLTYHE, CALIFORNIA, JANUARY 15, 1975

This report describes and analyzes an accident involving a schoolbus-type bus which ran off the roadway while attempting to negotiate a right angle turn at 45 to 55 mph and vaulted into a farm drainage ditch. The bus came to rest on its left side, partially submerged. The accident resulted in the death of 19 of the 47 occupants. Information used in the analysis of the accident was obtained by the California Highway Patrol, the Federal Highway Administration (Bureau of Motor Carrier Safety), the Riverside County (California) Coroner's Office; and the Ward Bus Company. The Safety Board concluded that the probable cause of the accident was the failure of the driver to reduce the speed of the bus to that required to negotiate the turn, despite the presence of a turn warning and velocity advisory speed sign. A lack of driver alertness induced by fatigue contributed to this failure. The 19 fatalities all resulted from drowning. It was concluded that the failure of the bus seat anchorages, apparently under low collision forces, resulted in the compressive packing of the seats and occupants, hampered rescue efforts, and contributed to the high number of deaths by drowning. Escape and rescue efforts were also complicated by the lack of sufficient exits and the

small size of window openings. A diagram of the accident scene and photographs of the site and the bus are provided.

National Transportation Safety Board, Bureau of Surface Transportation Safety, Washington, D.C. 20594
Rept. No. NTSB-HAR-75-1: SS-H-35 : 1975 ; 29p 10refs
Includes NTSB Hwy. Safety Recommendations H-75-1 through H-75-2.
Availability: NTIS

HS-018 367

HIGHWAY ACCIDENT REPORT. SERIES OF MULTIVEHICLE COLLISIONS AND FIRES UNDER LIMITED VISIBILITY CONDITIONS, NEW JERSEY TURNPIKE, GATE 15 AND U. S. ROUTE 46, OCTOBER 23 AND 24, 1973

The situation that existed before and during a series of multivehicle collisions which occurred under fog and smoke conditions on a high-speed, limited-access highway (the New Jersey Turnpike) during the late hours of October 23 and the early morning of October 24, 1973, is described and analyzed. In that period nine multivehicle accidents occurred, eight under limited-visibility conditions caused by smoke from burning material on an abandoned garbage dump and fog. A total of 66 motor vehicles were involved, nine persons were killed, and 39 others were injured. The National Transportation Safety Board determined that the probable cause of the collisions was the penetration of vehicles into areas of severely reduced visibility due to fog and smoke, the latter occasioned by fires adjacent to the turnpike which had not been promptly extinguished. The delay in closing the affected roadways by the New Jersey State Police contributed to the number of accidents. Included are recommendations to the New Jersey State Police, New Jersey Turnpike Authority, United States Environmental Agency, and the New Jersey Department of Environmental Protection, which are intended to prevent the recurrence of an accident of this type. Chronologies of events and fires and firefighting efforts are appended.

National Transportation Safety Board, Bureau of Surface Transportation Safety, Washington, D.C. 20594
Rept. No. NTSB-HAR-75-2: SS-H-33 : 1975 ; 48p 6refs
Includes NTSB Hwy. Safety Recommendations H-75-3 through H-75-8.
Availability: NTIS

HS-018 368

DIESTER SYNTHETIC LUBRICANTS FOR AUTOMOTIVE AND DIESEL APPLICATIONS

Four new diester-type synthetic lubricants are evaluated for automotive and diesel applications: 5W-20 automotive diesel; 10W-40 primarily diesel; 10W-40 automotive; and 10W-30 automotive diesel lubricant. The new lubricants potentially offer fuel savings, extended oil drain intervals, longer engine life, cleaner engines, reduced down time, labor savings, easier winter starting, and faster warmup. Standard passenger car engine sequence and extended sequence testing were performed on the lubricants in an effort to substantiate long drain potential. Diesel testing included Mack, General Motors and Caterpillar engines. The lubricants showed good lubricating and antiwear properties when properly formulated with additives tailored for the lubricants. They performed excellently in engine high temperature resistance, without increasing the oil

viscosity between a single and double IIIC test. Diester lubricants also enable engine start-up at very low ambients (minus 40°F). Use of extended oil drains with the lubricants in passenger cars was supported by limited field data and by extended sequence testing. Use of diesters as extended drain engine lubricants in diesel engines was supported by a Double Mack T-1 (400 horsepower) test. Field test work under extended oil drain conditions is planned. An appendix includes tables of static engine test results for Arctic Lubricant (5W-20); engine inspection summary of a General Motors 8V71N engine after approximately 200,000 miles of operation on 10W-40 primarily diesel; sequence testing results for 10W-40 automotive; 50,000 mile engine test data-key readings for automotive 10W-40; ratings for engines after 50,000 miles service with 10W-40 automotive and petroleum oil; additional wear data on engines lubricated with the mixture after 50,000 miles; used oil analysis data during the 50,000 mile engine wear test for the mixture; engine inspection data on 1972 Chevrolet Impala run on petroleum, and on the mixture; and sequence test results for the 10W-30 diesel and automotive lubricants.

by Roy H. Boehringer
Emery Industries, Inc.
Rept. No. SAE-750686 : 1975 ; 12p 5refs
Presented at the Fuels and Lubricants Meeting, Houston, Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 369

SIMULATION AND EVALUATION OF A 4-STROKE SINGLE-CYLINDER SPARK IGNITION ENGINE

The development and evaluation of a mathematical model for a 4-stroke, single-cylinder, spark ignition engine is presented in two parts. The first part deals with the development of the model and the computer program. In this work, the mathematical model was divided into two periods, the closed period, consisting of the compression, combustion, expansion process; and the open period comprising the exhaust and inlet processes. The closed period was solved by calculating the heat transfer, pressure, and temperature of the gases in the cylinder. The open period was solved by computing the mass flow rate across the valves, the properties at the mesh points of the intake and exhaust systems, and the temperature and pressure of the gas in the cylinder. In evaluation of the model, the pressure-time diagram for the gases in the cylinder, in the intake system, and in the exhaust system were measured in an instrumented engine. The computer program consisted of seven subroutines and a main program. In the second part the instruments that were developed for the evaluation of the model are included. Tables show: comparisons of computed and test data of cylinder pressure versus crank angle; computed data of species mole fraction versus crank angle; heat transfer coefficient and heat transfer rate; computed data of unburnt and burnt gas temperature; fractional volume burnt versus fractional mass burnt; and distance of flame front and flame velocity versus crank angle. Advantages and limitations of the model are given, and it is concluded that, although the simplified analysis is useful in some general areas, the detailed analysis must be used to provide detailed design criteria. The development of the detailed model is justified by its potential

for developing advanced engines and its systematization of engine know-how.

by M. K. Gajendra Babu; B. S. Murthy
Indian Inst. of Tech. (India)
Rept. No. SAE-750687; 1975; 27p 24refs
Presented at the Fuels and Lubricants Meeting, Houston,
Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 370

ON THE PROBLEM OF PREDICTING BURNING RATES IN A SPARK IGNITION ENGINE

Formulation of a mathematical model for flame propagation in a spark ignited reciprocating engine is described. A more logical approach was adopted, bringing in the concept of an engine Reynolds parameter as the criterion to determine the combustion acceleration due to turbulence, than was previously found by assuming a laminar flame propagation model with a suitable multiplying factor for turbulence effects. In the new model, laminar burning velocity is calculated from Semenov's thermal model for the instantaneous unburned gas condition during combustion and is augmented for engine gas turbulence through an empirical function of the engine Reynolds parameter assuming wrinkled flame model. The turbulent flame velocity thus obtained is then corrected for flame transportation due to the expansion of the burning gases. The empirical constants in the formula have been evaluated in correlation to results of extensive experimentation on a single cylinder variable compression ratio research engine. Tables are included which illustrate: a list of engine operating variables considered; a comparison of combustion parameters from measured and simulated cycle; a comparison of the computed results from these cycles; and comparisons of flame velocities and flame progress.

by B. S. Samaga; B. S. Murthy
Karnataka Regional Engineering Coll. (India); Indian Inst. of Tech. (India)
Rept. No. SAE-750688; 1975; 16p 16refs
Presented at the Fuels and Lubricants Meeting, Houston,
Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 371

MEASUREMENT OF EXHAUST GAS VELOCITY IN AN INTERNAL COMBUSTION ENGINE

A method of measuring exhaust velocity with respect to crank angle in a 4-stroke spark ignition engine involving a new means of automatically selecting a crank angle in an engine under running conditions is described. An instrument called the digital velocity meter (DVM) was developed for measuring transient exhaust gas velocity. The DVM receives the following inputs: regular disc pulses; top dead center pulse; and a pulse on the cam side at about 20 degrees before top dead center. Depending on the crank angle selected and the frequency of operation, a high-voltage pulse will be applied across two electrodes. This ionizes the flowing gas, and the ionized gas is then detected at a known distance with a detector whose output is further processed and fed to the stop gate of the universal integrator. Measuring probes comprised of

and firing conditions. In the case of firing conditions, different exhaust configurations were tried and the cycle-to-cycle fluctuations in velocity were also measured. On comparison of the data obtained at all the measured points and for all the configurations, it was found that the cycle-to-cycle fluctuation is smaller in the nozzle and bend case. It was also observed that the fluctuation increases with speed. It is concluded that the experiments demonstrate that the direction of flow in the exhaust system can be controlled by providing the proper exhaust configurations. Possible applications of this exhaust velocity measurement include: tuning exhaust systems; determining the available energy in the exhaust gases, so that a turbocharger can be designed; and pollution control.

by M. K. Gajendra Babu; P. A. Janakiraman; B. S. Murthy
Indian Inst. of Tech. (India)
Rept. No. SAE-750689; 1975; 10p 3refs
Presented at the Fuels and Lubricants Meeting, Houston,
Tex., 3-5 Jun 1975. Partially supported by a grant from the U.S. National Science Foundation.
Availability: SAE

HS-018 372

LOW-TEMPERATURE ENGINE OIL PUMPABILITY IN FULL-SCALE ENGINES

The American Society for Testing and Materials' (ASTM) Committee D-2 has undertaken a program to develop a laboratory test which correlates with low-temperature engine oil pumpability in field service. As the first step in the program, pumpability data were obtained using 13 ASTM pumpability reference oils in seven full-scale engines. Pumpability Reference Oils were run in each of the engines at various temperatures, and the results were classified in terms of the gallery oil pressure-time response. The pumpability condition was classified as: normal, if gallery oil pressure was greater than 20 psig at all times after one minute of operation; borderline, if gallery oil pressure was equal to or less than 20 psig but greater than 6 psig at any time after one minute of operation; and no pump, if gallery oil pressure was 6 psig or less at any time after one minute of operation. The engines and oils were chosen to be representative of a wide range of commercial practice. The mode of pumping failure in the engines and the times required to lubricate the rocker arms were also obtained. Results indicate that substantial differences in pumpability exist among both engines and oils. Possible reasons for these differences are suggested, based on engine oil pump inlet system characteristics and the viscometric properties of the oils. It is concluded that: engine design and oil characters both significantly affect low-temperature pumpability; pumpability failures occur when there is insufficient flow either to the oil screen, or between the screen and oil pump; and the Society of Automotive Engineers' winter viscosity grade is not a reliable indicator of low-temperature engine oil pumpability. The borderline pumping temperature and failure mode developed in the program can and should serve as the basis for evaluating the ability of a laboratory bench test to predict engine oil pumpability at low temperatures.

by M. L. McMillan; R. M. Stewart; M. F. Smith, Jr.; S. W. Rein
General Motors Res. Labs.; Gulf Res. and Devel. Co.; Exxon Chemical Co., PARAMINS Technology Div.; Texaco, Inc.
Rept. No. SAE-750691; 1975; 12p 14refs
Presented at the Fuels and Lubricants Meeting, Houston

THE INFLUENCE OF POLYMER ADDITIVES ON THE JOURNAL BEARING PERFORMANCE

Temporary viscosity loss experienced by non-Newtonian lubricants, operating in a simulated engine bearing, has been determined. Lubricant blends containing 13 commonly-used viscosity index improvers and six commercial multigraded engine oils were included in the study. Bearing friction and minimum oil-film thickness data were used to determine the temporary viscosity loss. For the 13 viscosity index improvers, the temporary loss ranged from 20 to 96 percent of the polymer contributed viscosity. Results indicate that low shear rate viscosity determinations, such as the currently used American Society for Testing and Materials D445, should not be used to characterize the behavior of lubricants in this category in high-speed engine bearings. In general, polymer additives which increase the minimum oil-film thickness also increase friction by a proportional amount. Of the five additive classes examined—polymethacrylate; styrene polyester; polyacrylate; polyisobutylene; and olefin-copolymer—no one class was shown to be superior.

by Richard C. Rosenberg
General Motors Corp., Res. Labs.
Rept. No. SAE-750692; 1975; 15p 15refs
Presented at the Fuels and Lubricants Meeting, Houston,
Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 374

EFFECT OF VI IMPROVER ON THE IN-SERVICE VISCOSITY OF HYDRAULIC FLUIDS

A vane pump rig was used to study the permanent and temporary shear loss characteristics of hydraulic fluids containing a variety of VI improvers. The vane pump test rig utilizes a vane pump test loop and provides for a correlation between pumping efficiency and in-use fluid viscosity. The hydraulic fluids tested included Newtonian oils used for calibration and referencing purposes and polymer-containing oils which utilized VI improvers of the following chemical types: polymethacrylates; hydrogenated styrene-diene copolymers; polyisobutylene; and an ethylene-propylene polymer. Severity of hydraulic oil service was assessed relative to that for automotive engine oils. The influence of polymethacrylate VI improver molecular weight on performance was investigated. The magnitude of both permanent and temporary shear losses was found to be a smooth function of molecular weight for a series of polymethacrylates. VI improvers which are completely shear and stable in automotive engine or oil service were found in some cases to be quite unsuitable for use in hydraulic oils; in fact, even the relative shear stabilities of VI improvers in engine oils were found to be of no significance to performance in hydraulic fluids. Even in systems which suffer large permanent viscosity losses, vane pump flow output was shown to be flatter as a function of time than would be expected. It is concluded that this results from the fact that temporary shear effects dominate in new fluids, while permanent shear effects dominate in used fluids.

by R. J. Kopko; R. L. Stambaugh
Rohm and Haas Co.
Rept. No. SAE-750693; 1975; 12p 31refs
Presented at the Fuels and Lubricants Meeting, Houston,
Tex., 3-5 Jun 1975.
Availability: SAE

USE OF SAFETY BELTS IN FINLAND IN THE EFFECT OF OBLIGATORY USE OF SAFETY BELTS ON THE VOLUME OF USE

The effects of legislation requiring the use of safety restraint systems in motor vehicles in Finland on the actual use of such safety belts were investigated. The use of safety belts was observed on highways on weekdays and on Sundays, on exit roads at peak hours, and in urban areas during the day and at peak hours without stopping the observed vehicles. About 165,000 drivers and 90,000 front seat passengers were observed. The survey showed that the greatest increase in use after the implementation of the legislation was in urban traffic, where use increased from 9% to 53%, although use of the safety restraints in urban traffic was still considerably lower than use under other traffic conditions. Use of the restraints on highways on weekdays increased from 30% to 68%; on highways on Sundays it increased from 40% to 71%; and on exit roads at peak hours it increased from 23 to 71%. Speed limits and weather conditions also affected the voluntary use of safety belts, but seemed to have no effect on the use after the legislation became effective. Interviews conducted with the drivers of about 8,000 vehicles which were stopped were used to collect information on the year of registration of the vehicle, the installation of restraint systems, and the use of the safety restraints. These interviews indicated that less than 50% of the cars were registered before 1971, that slightly over 50% of the cars registered before 1971 were equipped with safety belts, that about 80% of all cars were fitted with safety belts, and that safety belts were used in 88% of cars fitted with them. It is concluded that making the use of safety belts compulsory by legislation in Finland resulted in increased use of safety belts and that the legislation has been obeyed rather well, particularly in long distance traffic.

by Liisa Oranen
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Roobertinkatu 20, 00120 Helsinki 12, Finland
Rept. No. Liikenneturva 15/1975; 1975; 27p 6refs
Availability: Corporate author

HS-018 376

DAY AND NIGHT VISIBILITY OF PUBLIC EMPLOYEES ON THE STREETS AND HIGHWAYS

A significant number of public employees on the streets and highways are struck by vehicles in which the driver states that he could not see the pedestrian in time to avoid hitting him. This has led to an analysis of the average threshold distance at which target colors, to be worn by the employee working in or around the roadway, can be detected. Fluorescent colors have been shown to have more than a two-to-one improvement in distance, compared to regular colors, in daylight. However, at nighttime, regular white colors have more conspicuity than fluorescent colors, and phosphorescent colors have more conspicuity than either white or fluorescent. Materials with the greatest nighttime brightness are those with retroreflective colors. In order to determine how much retroreflective material was needed for nighttime pedestrian conspicuity, a study was undertaken to examine the supra-threshold aspect of conspicuity which is needed to alert a complacent, distracted or inattentive driver to the presence of a person or object in the roadway. The study related measured brightness and area properties of certain light targets under static dark, ambient conditions to the subjective responses of observers. In order to

link the photometric and area properties of visual targets to observer reaction, a preliminary research was done using targets of randomly varied brightness and area at a fixed distance of 550 feet. Observers, sitting behind standard headlights, were asked to rate each target presented as to whether it was "visible," "easily visible," or "attention getting." It was found that all of the test results could be most simply depicted on a single graph and thresholds of visibility, plotted on a graph, were found to be coincident with base lines of a visible range.

by Donald J. Klassen

Publ: National Safety Congress Transactions v8 p47-50 (1974) 1974

Availability: See publication

HS-018 377

MOTORCYCLE SAFETY EDUCATION. GUIDELINES FOR INSTRUCTOR PREPARATION

Direction is provided for teacher educators responsible for developing and conducting instructor preparation courses in motorcycle safety education. Six instructional units are detailed: novice instructional program, rider proficiency, practice teaching, test administration, organization and administration, and advanced rider course. Each unit is organized to provide the teacher with: unit objective, content, student activities, teacher activities, and unit resources. Also provided are an extensive listing of resource reference sources, direction in preparing for instruction and in course scheduling, and several instructional schedules that allow the university instructor to schedule and implement courses under differing time constraints.

by Kenard McPherson; James A. Smith, Jr.
Motorcycle Safety Foundation, 6755 Elkridge Landing Rd.,
Linthicum, Md. 21090

1975 ; 44p 14refs

Availability: Corporate Author

HS-018 378

RIDING TIPS FOR THE MOTORCYCLIST

Motorcycle rider population began to increase tremendously in the mid-1960's and is expected to increase until levelling out in the mid-1970's. With this growth has come a corresponding increase in motorcycle related accident statistics. Some positive steps are necessary to decrease the trend for motorcycle accidents, and one of the more important steps is to inform the motorcycle rider about the special techniques and conditions vital to safe motorcycle operation. The Motorcycle Safety Foundation has prepared a booklet in an effort to provide some of the tips for safe operation of the motorcycle. These include: safety checks; starting and braking of the motorcycle; protective gear; road riding; insurance; and riding under special conditions, such as in rain, at night or at high speeds.

Motorcycle Safety Foundation, 6755 Elkridge Landing Rd.,
Linthicum, Md. 21090

1974 ; 20p

Availability: Corporate author

HS-018 379

STEERING REVERSALS AS A MEASURE OF DRIVER PERFORMANCE AND STEERING TASK DIFFICULTY

A review is made of past work in which steering reversal rates were used as a measure of driver performance. The data from two previously reported experiments carried out in a controlled situation are used to compare steering reversal rates with other performance measures. It is shown that, while steering reversal rates correlate with other measures of control frequency, they do not necessarily correlate with measures of absolute steering performance. This result is consistent with the view that frequency characteristics provide a measure of steering task difficulty rather than steering performance. It is shown that, when considering steering task difficulty, care must be taken to differentiate between the difficulty imposed by the task constraints and the factors which affect the driver's ability to maintain a level of performance commensurate with those constraints.

by John R. McLean; Errol R. Hoffman

Publ: Human Factors v17 n3 p248-56 (Jun 1975)

1975 ; 12refs

Supported by the Australian Road Res. Board.

Availability: See publication

HS-018 380

TRAFFIC FLOW THEORY. A MONOGRAPH

Traffic flow theory is a useful tool in designing and operating streets and highways efficiently, serving the dual purposes of aiding the understanding of traffic behavior and predicting the future performance of the system. There are currently several theoretical approaches to describe traffic behavior through the application of the laws of physics and mathematics, rather than a unified theory of traffic flow. The measurement of traffic flow, speed, and concentration are basic to any model of traffic behavior. The types of models being applied to traffic flow analysis include: statistical distribution models; traffic stream models; driver information processing analysis; car following and noise acceleration models; hydrodynamic and kinematic models; queueing models; and computer simulation models. Extensive bibliographies are presented and each of these models is illustrated.

by Daniel L. Gerlough; Matthew J. Huber
University of Minnesota

Rept. No. TRB-SR-165 ; 1975 ; 226p refs

Updated and expanded version of Hwy. Res. Board Special Report 79. Includes: HS-018 381--HS-018 389. Supported by the Federal Hwy. Administration.

Availability: TRB \$20.00

HS-018 381

INTRODUCTION [TO TRAFFIC FLOW THEORY]

Traffic flow theory is a useful tool in designing and operating streets and highways efficiently, serving the dual purposes of aiding the understanding of traffic behavior and predicting future performance. At present, there are several theoretical approaches to describe traffic behavior through the application of the laws of physics and mathematics, rather than a unified theory of traffic flow. Models of traffic flow may be classified

tempts to model the fundamental traffic characteristics of flow, speed, and concentration, it is important to have unambiguous definitions of these characteristics in relationship to the methods of measurement, as well as the appropriate methods of computing averages and other desired data. Statistical distribution models make it possible to predict the performance of traffic with respect to such particular characteristics as the number of vehicles likely to arrive in an interval or speeds exceeding a certain value with a minimal amount of information. Traffic stream models are used to relate pairs of the basic traffic flow characteristics, such as speed/flow, speed/concentration, and flow/concentration. Some traffic flow models include consideration of driver information processing characteristics. Car following analysis considers the dynamics of a stream of traffic which result when a series of drivers attempt to regulate their acceleration to achieve a smooth, safe trip. Acceleration noise is developed as a measure of the quality of traffic flow. Hydrodynamic and kinematic models of traffic flow attempt to describe traffic in terms of fluid behavior and are concerned with the overall statistical behavior of the traffic stream rather than with the interactions between individual vehicles. Queueing models, which employ methods of probability and statistics, provide a means for predicting some of the delay characteristics, such as the length of time a vehicle or pedestrian must wait or the number of units waiting in line. A variety of traffic flow simulation models have been developed to analyze and predict traffic situations which are too complex to be handled by the other models.

by Daniel L. Gerlough; Matthew J. Huber
University of Minnesota
Publ: HS-018 380 (TRB-SR-165) Traffic Flow Theory,
Washington, D.C., 1975, Chap. 1, p1-6
1975 : 2refs
Availability: In HS-018 380

HS-018 382

MEASUREMENT OF FLOW, SPEED, AND CONCENTRATION

In order to model the fundamental traffic characteristics of flow, speed, and concentration; it is important to have unambiguous definitions of these characteristics in relationship to the methods of measurement, as well as the appropriate methods of computing averages. Potential methods of measurement include measurements at a point, along a length (by photography), and by a moving observer. To obtain useful data at a point, it is necessary to cover extensive time periods, with all characteristics expressed as averages. Flow, speed (either spot speed or harmonic mean speed), concentration, and lane occupancy can be measured at a point. From an aerial photograph (or a photograph from a high building) it is possible to scale a distance and count the vehicles in this distance. With two photographs spaced a short time apart, it is possible to measure speeds and flows. The measurement of traffic by one or more moving observers has proved to be an effective method of assessing traffic along an arterial or in an area. With this method, an observation car travels first with the traffic being measured and then returns in the direction opposite to that of the traffic being measured. An observer in the car records the travel time for each direction. For the trip with the traffic stream the number of vehicles that pass the observation car and the number of vehicles passed by it are also recorded. For the trip opposite to the traffic stream the number of cars passed in the stream are recorded. Equations

used in the various methods of measurement are presented and discussed. Supplementary data are given in Appendix A.

by Daniel L. Gerlough; Matthew J. Huber
University of Minnesota
Publ: HS-018 380 (TRB-SR-165) Traffic Flow Theory,
Washington, D.C., 1975, Chap. 2, p7-15, 199-201
1975 : 32refs
Availability: In HS-018 380

HS-018 383

STATISTICAL DISTRIBUTIONS OF TRAFFIC CHARACTERISTICS

The statistical distributions of various traffic characteristics deal with two types of quantities. First is the vehicles' counts or flows that mainly have discrete distributions such as Poisson for low density traffic; negative binomial distribution, for varying flows; and the generalized Poisson as well as the binomial, for congested flows. The second type are those that obey continuous distributions, such as headways (exponential, shifted exponential, composite exponential, Erlang, hyper-Erlang, semirandom, and normal) and speeds (normal, lognormal, and gamma). The choice of distribution depends on how much complexity is desired, as well as on the behavior of the traffic. Applications of many of these statistical distribution models demonstrated that if the vehicle count obeys a given discrete distribution, the headway will obey a unique corresponding distribution. For example, if flow is purely random (Poisson), headways are exponentially distributed. If the headways have an Erlang distribution of order "k" (positive integer), the corresponding flow is itself a discrete event variable consisting of every "kth" event of a Poisson series. This unique correspondence, although true, is difficult to obtain under real conditions except for special cases; that is, to the discrete flow process there corresponds a continuous headway process. Gap acceptances were found to obey either the Erlang or the lognormal distributions. Probabilities were useful for expressing the normal scales. Demonstrations of the various statistical distribution models and an extensive bibliography are included. Supplementary data are given in Appendix B.

by Daniel L. Gerlough; Matthew J. Huber
University of Minnesota
Publ: HS-018 380 (TRB-SR-165) Traffic Flow Theory,
Washington, D.C., 1975, Chap. 3, p17-47, 202-12
1975 : 152refs
Availability: In HS-018 380

HS-018 384

TRAFFIC STREAM MODELS

Traffic stream models predict the relationships among speed, concentration, and flow. From a causation viewpoint, the speed-concentration relationship appears to be the most fundamental, in that drivers appear to adjust their speeds according to the concentration of the traffic around them. The flow/concentration relationship is generally the most useful because it unifies various theoretical ideas and provides relationships for traffic control activities. Speed/concentration models include linear relationship models, logarithmic models, generalized single-regime models, and multiregime models. The use of the flow/concentration curve permits the unification of the speed/flow relationship approach to low concentrations and the headway phenomena approach to high concentrations. Flow/concentration models include parabolic models; discon-

ous models, such as to describe one-lane flows; and logarithmic models. The flow/concentration representation of the traffic stream is frequently used to study capacity and to control flows on freeways. Once a speed/concentration model has been determined, a speed/flow model can be determined from it. Models have been developed to analyze travel time/flow relationships and travel time/concentration relationships. Several of these traffic stream models are demonstrated. It is concluded that the model selected for a specific application must depend on the particular situation and purpose of the analysis, but that the simplest appropriate model should be used unless there is some strong reason to use a more complicated model. An extensive bibliography is included.

by Daniel L. Gerlough; Matthew J. Huber
University of Minnesota
Publ: HS-018 380 (TRB-SR-165) Traffic Flow Theory,
Washington, D.C., 1975, Chap. 4, p49-70
1975 ; 58refs
Availability: In HS-018 380

HS-018 385

DRIVER INFORMATION PROCESSING CHARACTERISTICS

The driving task consists of receiving information from the roadway, other cars, and the environment and of reacting to the various stimuli received by control of heading or control of acceleration. The task of accomplishing the driver's goals may be categorized into the following types of actions: perception, judgment, decision, and control. Control actions are limited to control of acceleration, including braking and acceleration, and control of heading, including steering or tracking. The tracking or steering subtasks can be described in terms of a servo system, and several models to describe the driver's actions as part of the servo loop have been proposed. To accomplish the steering function, the driver attempts: to select a reference from which to determine steering error; to detect such errors; to establish an error criterion; and to respond to the detected error in such a manner as to maintain the vehicle within the established criterion limits throughout the duration of the steering task. The acceleration control subtask consists of detecting differences in velocity and/or spacing and taking actions that will prevent unsafe conditions and fulfill the driver's goal of proceeding at a particular speed and any other goals that he/she may have. The information needs of the driver will vary with the portion of the trip and the immediate maneuver to be accomplished. The driver uses a variety of senses to gather information required for the driving task, the most important of which is visual inputs. Models of human response to stimuli and of information processing indicate that while the information rate of the human eye can be up to 4.6 times ten to the sixth power bits per second, the human information processing channel has a maximum rate in the vicinity of 25 to 35 bits per second. Drivers must therefore do selective filtering of the visual information. Indications from experimental testing are that the driver normally scans the highway about 5 seconds ahead. If the situation is changing relatively slowly, however, the driver may look farther ahead and thereby increase the information input. Testing indicates that the motor response in time is relatively constant and that judgment and decision time, including perception and informa-

tion processing time, varies with the complexity of the situation and the decision to be made.

by Daniel L. Gerlough; Matthew J. Huber
University of Minnesota
Publ: HS-018 380 (TRB-SR-165) Traffic Flow Theory,
Washington, D.C., 1975, Chap. 5, p71-86
1975 ; 76refs
Availability: In HS-018 380

HS-018 386

CAR FOLLOWING AND ACCELERATION NOISE

Car following models have been developed to analyze the dynamics of a stream of traffic which result from a series of drivers in a single-lane attempting to regulate their accelerations to achieve a smooth, safe trip. Car following models are a form of stimulus-response equation, where the response is the reaction of a driver to the motion of the vehicle immediately preceding him in the traffic stream. The response of successive drivers in the traffic stream is to accelerate or decelerate in proportion to the magnitude of the stimulus and begins after a time lag. The question of stability in a platoon of vehicles is important in reviewing different patterns of car following behavior in consideration of traffic behavior modification activities. It is important to determine that the system is stable, so that a change in the velocity of the lead vehicle will not be amplified by successive vehicles in the platoon. It has been demonstrated that it is possible to derive equations of traffic stream flow directly from the laws of motion that are suggested by car following theory. Car following models, and the resultant traffic flow models, are illustrated and the equations used are presented and discussed. Car following models can be applied to analyze traffic behavior in tunnels or on crowded highways, to evaluate aids to driver car following, to examine the behavior of platoons of busses on an exclusive freeway lane, to anticipate the effect of short cars on the flow and speed of downtown traffic, and to examine safety in car following. A measure of the fluctuations of a driver is given by the standard deviation of the acceleration about the mean acceleration and is defined as the acceleration noise. Acceleration noise is mainly influenced by the driver, the road, and traffic conditions. Equations for determining the acceleration noise are illustrated.

by Daniel L. Gerlough; Matthew J. Huber
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Washington, D.C., 1975, Chap. 6, p87-109
1975 ; 56refs
Availability: In HS-018 380

HS-018 387

HYDRODYNAMIC AND KINEMATIC MODELS OF TRAFFIC

Hydrodynamic and kinematic models of traffic flow attempt to describe traffic in terms of fluid behavior and are concerned with the over-all statistical behavior of the traffic stream rather than with the interactions between individual vehicles. Traffic can be analyzed by means of "waves" of constant flow and, hence, on roads of constant roadway geometry and environment, by constant speed and concentration. When there is a change in flow resulting from changes in roadway geometry or condition, shock waves can develop. Techniques have been developed by which shock waves can be plotted

and used to predict performance of the traffic system. Applications of these techniques to freeway bottlenecks and to traffic signals are demonstrated. A model using a traffic "fluid state" assumption also appears in car following models, giving limited confidence in the relationship between the microscopic and macroscopic theories of traffic. Platoon diffusion can be represented by a model that is analogous to the diffusion of gases. Techniques of applying this model to signal timing are illustrated. One model of traffic attempts to integrate low density flow (individual vehicles) and high density flow (platoons) into a single model. This kinetic theory of traffic flow recognizes three different main features of multilane traffic and treats them as separate processes in the theory. These features are: the relaxation process, or the speeding-up process, that expresses the attempts of the drivers to achieve their own desired speeds; the interaction process, or the slowing-down process, that arises in the conflict between a faster driver and a slower driver; and the adjustment process that reduces the variance around the mean speed. Results achieved from the application of this model to traffic flow are considered promising. Supplementary data are given in Appendix C.

by Daniel L. Gerlough; Matthew J. Huber
University of Minnesota
Publ: HS-018 380 (TRB-SR-165) Traffic Flow Theory,
Washington, D.C., 1975, Chap. 7, p111-35, 213
1975; 47refs
Availability: In HS-018 380

HS-018 388

QUEUEING MODELS

Queueing models, which use methods of probability and statistics, provide a means for predicting some of the delay characteristics of traffic flow. In order to mathematically predict the characteristics of a queueing system, it is necessary to specify the following system characteristics and parameters: arrival pattern characteristics; service facility characteristics, including the service time average rates and distribution and the number of customers that can be served simultaneously; and queue discipline characteristics, such as the means by which the next customer to be served is selected. Applications of queueing theory and models to traffic flow analysis include: delay problems that occur when all users pass through a single-channel control point, such as a left-turn slot; delay problems that occur where there are several channels of service, such as several parallel toll booths or the different stalls of a parking facility; delays at unsignalized intersections; delays at complex intersections having both traffic and pedestrian signal controls; and delays caused by accidents or railroad crossings. The model for service through a single channel is developed in detail because it demonstrates the relationship between probability theory and behavior in waiting lines.

by Daniel L. Gerlough; Matthew J. Huber
University of Minnesota
Publ: HS-018 380 (TRB-SR-165) Traffic Flow Theory,
Washington, D.C., 1975, Chap. 8, p137-73
1975; 92refs
Availability: In HS-018 380

HS-018 389

SIMULATION OF TRAFFIC FLOW

A variety of traffic flow simulation models have been developed to analyze and predict traffic situations which are too complex to be handled by simple mathematical models. These simulations use a digital computer to implement a model. The major reasons for simulation include the need to test the behavior of a new system or operating procedure prior to its actual construction and the need to test alternate systems under identical conditions. One of the most important features of simulating traffic is the ability to generate random events. Model formulation must include selection of the following items: the traffic situation to be simulated; the measure of effectiveness to be used; the degree of complexity to be included; the traffic generation (arrival) model to be used; the model for processing traffic through the simulated situation; the computer language to be used; and the computer to be used. Model formulation is demonstrated through the application of simulation models to intersection load factor analysis, analysis of a simple four-way intersection, and analysis of a freeway merging area. The statistical design of a simulation experiment is important in order to minimize the amount of experimentation and to enable inferences with the desired levels of significance. Simulation experiments permit easier control over the several variables than do field experiments and permit the performance of additional replications at will. Experimental design of simulation tests should include: consideration of such problems as the selection of factor levels and factor combinations, the order of experimentation, the minimization of random error, as well as classical and computer simulation design problems; and a plan for starting simulation runs and validation procedures. It is concluded that traffic simulation programs that are properly modeled and validated constitute important experimental facilities for traffic study. Supplementary data are given in Appendix D.

by Daniel L. Gerlough; Matthew J. Huber
University of Minnesota
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Washington, D.C., 1975, Chap. 9, p175-95, 214-8
1975; 89refs
Availability: In HS-018 380

HS-018 390

SAE'S HARD LOOK AT LIGHTWEIGHT MATERIALS

The use of lightweight materials in automobile construction is discussed. These lightweight materials include plastics, aluminum, high strength low alloy (HSLA) steel, and thin-gage mild steel. The Chrysler Corporation has developed a lightweight, experimental, high-strength vehicle which uses a large amount of HSLA steel and aluminum. Oldsmobile engineers have developed a production system for all-aluminum or all-steel hoods, and some of its new cars will be equipped with all-aluminum hoods. Pontiac Motor Division produced the "Phoenix" experimental car, which used two high-strength plastics for such applications as door impact beams, wheels, bumper back-up beams, radiator supports, and transmission supports. The use of reaction injection molded (RIM) plastic automotive parts has been evaluated by engineers and chemists as a potentially fast, economic means for producing large parts. A variety of RIM-made parts will be used in the construction of 1977 model vehicles. A high-strength all-aluminum alloy will be used for bumpers in some 1977 models.

August 31, 1976

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The use of the aluminum alloy 7046 for other major body panel applications, particularly hoods, is currently being investigated. HSLA materials that can be formed easily into parts of different sizes and shapes and that can also be produced in large volume are being developed. One such HSLA material includes about 1% manganese, 1% nickel, and 3.5% chromium and is said to be as formable as conventional car body steel.

by Al Wrigley

Publ: Ward's Auto World v12 n3 p56-7, 60-1 (Mar 1976)
1976

Availability: See publication

HS-018 392

SPLASH AND SPRAY TESTS

Studies on the suppression of vehicle splash and spray have been going on for several years and have resulted in some changes in aerodynamic design and the addition of various types of splash and spray deflectors. The development of high speed highways in the past several years has significantly increased the problems created by splash and spray from trucks. The Western Highway Institute conducted two controlled tests of the effectiveness of various truck splash and spray suppression devices on various truck configurations and under actual adverse weather conditions. The most significant findings of these tests were that side fenders or skirts, while fairly effective in suppressing the spray coming off the top of the wheel, also could cause excessive heat buildup in brakes and tires. Two devices tested which showed no objectionable heat buildup characteristics were a wheel spray collector device and an air vane deflector. Tests conducted at the Firestone Test Center in Texas indicated that those devices designed to trap the water generally appeared to collect it faster than the system was able to drain it off. Most of the sponsors of devices tested at the Test Center indicated that this opportunity to observe their devices operating under controlled conditions had demonstrated aspects which could be improved. Air and water deflection devices showed that good results can be obtained by such methods when these are placed in the proper locations. Many sponsors were made aware of the desirability of using lighter weight materials and improving the operation and installation features. It appears that methods of redirecting the water to non-critical locations may provide the ultimate solution. Photographs of devices tested are included.

by Thurm Sherard

Publ: Go-Transportation Times of the West v32 p38-9, 42, 44-5, 48, 50-2 (Oct 1972)
1972

Availability: See publication

HS-018 393

PHYSICS OF COLLISIONS. FINAL REPORT

The physical basis of rail car collision analysis and car structure design is explained in an effort to clear up misconceptions about rail car structure. The fundamental concepts governing what happens in a collision are the laws of conservation of momentum and conservation of energy. The critical element in equations governing the destructiveness of crashes is the ener-

heat and noise. The destructiveness of the crash will be smaller for smaller masses. With lightweight cars there will be less energy with which to cause damage in a given collision. For a given structural strength, light cars should be damaged less than heavy ones. It is not the weight of the vehicle but its internal construction that determines its susceptibility to damage in a given accident. Perfectly rigid cars may reduce damage to the cars but will not protect passengers from injuries due to collisions. Energy absorbing front ends are probably practical for up to about a 20 mph crash, but there will be considerable injury to passengers not attached to cars by some form of seat belt or other restraint. Analysis of rail car collision physics indicates that there are basic limitations on the extent to which passenger safety can be improved by building crashworthiness into cars.

by Donald Raskin

Transit Devel. Corp., 1730 M St., N. W., Washington, D.C.
20036

Rept. No. TDC/500-74/6; PB-241 852; 1974; 13p

Availability: NTIS

HS-018 395

REDUCING THE DAMAGE OF MOTOR-VEHICLE USE

Possibilities for reducing the damage to people and property resulting from motor vehicle accidents are systematically identified using a simple options analysis that includes ten possible strategies. The theoretically possible strategies include: prevent the initial marshalling of the form of energy by discontinuing the production and importation of fuel or not constructing or using motor vehicles; reduce the amount of energy marshalled through such actions as restricting fuel supply, reducing the size of vehicles produced, and reducing the speed capabilities of the vehicles; prevent the release of energy through such measures as better road signs, better vehicle visibility and brakes, better police work to reduce crashes, and restrictions on high risk drivers; modify the rate or spatial distribution of release of energy from its source through the use of passenger restraint systems; separate in space or time the energy being released from the susceptible structure through the elimination of vehicle intersections with other vehicles, with pedestrians, and with roadside structures by using under- and over-passes, sidewalks, and cycle and bus lanes; interpose a material barrier to block or attenuate the energy transfer, such as crash helmets, median guardrails, and vehicle structures and dimensions designed to provide smooth deceleration for occupants; modify the contact surface, sub-surface, or basic structure which can be impacted, such as redesign of front-end configurations, elimination of interior hazardous objects, and making signs and poles of a yielding material; strengthen the living or non-living structure which can be damaged by the energy transfer, such as providing bumpers capable of taking common types of impact and fuel systems and tank trailers which will not rupture in impacts at any speed of operation for which they are designed to be used; move rapidly in detection and evaluation of damage and counter its continuation and extension through the installation of emergency roadside telephones, scoring systems for quickly evaluating the seriousness of injury, and providing for emergency, on-the-scene medical care; and post-emergency loss-reduction measures such as design of vehicles for ease and in-

social, and political forces involved as well as a systematic analysis of options and the likely benefits of their implementation.

by William Haddon, Jr.

Publ: Technology Review v77 n8 p52-9 (Jul/Aug 1975)

1975; 7refs

Availability: See publication

HS-018 396

EMERGENCY VEHICLE DRIVER TRAINING IN VIRGINIA

A mail survey was conducted in the State of Virginia to identify the current status of training of emergency vehicle operators and the agencies which would participate in a training program if it were developed. The questionnaire was mailed to 212 police and sheriff's departments, 254 fire departments, 197 ambulance services, and 201 rescue squads throughout the state. The survey indicated that about 4,200 new drivers are employed annually and little field training of these drivers is provided under test conditions. About 8% currently receive no driver training, 14% are trained through utilization of a driver training range, and the remaining 78% receive classroom instruction only or are trained while driving under the supervision of an experienced driver. The Northern Virginia Police Academy and the Virginia State Police both provide extensive training in emergency vehicle operations to police officers. The study results indicate that driver training should be made available to all operators of emergency vehicles, with all students receiving both classroom and field training in defensive driving, emergency vehicle operations, and special conditions. In addition to these areas of training, drivers of fire equipment also need training in precision truck driving and police department drivers may need training in pursuit driving. The use of a test course to permit actual vehicle operations under controlled conditions is desirable. Driver training simulators can also be used with special films for emergency vehicle operations. It is recommended that a program for training emergency vehicle operators utilizing driving simulators and a driver training course be developed as soon as possible. The construction of a central driver training facility in the State should be investigated, and the use of mobile simulation units should also be considered.

Wilbur Smith and Associates, Caskie House, 2 North 5th St., Richmond, Va. 23219

1973; 33p 4refs

Prepared for the Commonwealth of Virginia Div. of Hwy. Safety in cooperation with the National Hwy. Traffic Safety Administration.

Availability: Division of Hwy. Safety, P. O. Box 1299, Richmond, Va.

HS-018 397

EFFECTS OF DISK MATERIAL SELECTION ON DISK BRAKE ROTOR CONFIGURATION

The thermal mechanisms that produce "disk cracking" in caliper disk brakes and how disk material selection affects the disk configuration are discussed. Several disk materials and configurations were tested in both air/oil and air/mechanical disk brakes on a dynamometer under various test parameters. Photographs of various disk fatigue failures are provided. The effects of thickness and ventilation, thermal shock and thermal

fatigue on disk strength are considered. Stress and stress analysis and temperature prediction computations are explained. It is concluded that: heat checking can be induced in most of the common disk materials, but the point at which it occurs is dependent upon loadings and disk material characteristics; the effects of heat checking are far more detrimental to the longevity of gray and ductile irons than to steels; the effects of elevated temperature on the thermal properties of gray irons, ductile irons, and steel tend to produce an alignment of properties, which, in turn, produces an increasing dependency on modulus of elasticity and fatigue properties to reduce heat checking and fatigue; a suddenly induced temperature change of about 200°F would be sufficient to produce conditions for heat checking; surface temperatures in excess of 1500°F do exist and result in plastic flow at the surface of the disk; and the metal's ability to withstand plastic flow will establish its resistance to heat checking and fatigue. The study also showed that: the effects of surface cooling become increasingly more important with increasing peak surface temperatures; increasing section thicknesses, particularly in gray irons, results in decreasing values in yield and tensile strength, thus reducing their ability to resist heat checking; increasing the disk's ability to dissipate heat through ventilation will produce a larger transverse temperature gradient which will increase transverse stresses; and the lining contact area changes during a stop, imposing a force concentration that results in a locally high surface temperature.

by Jack D. Rainbolt

B. F. Goodrich Engineered Systems Co.

Rept. No. SAE-750733; 1975; 24p 4refs

Presented at the West Coast Meeting, Seattle, Wash., 11-14 Aug 1975.

Availability: SAE

HS-018 398

A METHOD OF DISTRIBUTING UNLEADED GASOLINE

A study was made to determine how to distribute unleaded gasoline from the refinery to the customer without exceeding the contamination limits of no more than 0.05 grams of lead and 0.005 grams of phosphorus per gallon. It was found that the handling procedures normally used for unleaded gasoline were inadequate. Sampling, in the period 1970-1973, of unleaded gasoline at refinery, pipeline and marketing terminal tanks, in truck transport to service stations, and at service stations revealed the need for the following transport procedures: delivery trucks should have only unleaded gasoline on board when delivering; truck transport compartments, manifolds and lines should be thoroughly drained before loading unleaded gasoline if the previous load was some other product; and service station storage tanks should be equipped with lock-type fill caps and kept locked at all times. These procedures were applied to marketing terminals serving 293 service stations, found effective, and applied to the entire distribution system of a refinery. It was confirmed that the new method of handling unleaded gasoline enabled the refinery to meet the prescribed contamination limits on lead and phosphorus.

by Raymond H. Klein; Walter R. Tuuri

Standard Oil Co. (Ohio)

Rept. No. SAE-750694; 1975; 7p 4refs

Presented at the Fuels and Lubricants Meeting, Houston, Tex., 3-5 Jun 1975.

Availability: SAE

REMOVAL OF LEAD CONTAMINATION FROM UNLEADED GASOLINE

Various systems were developed for deleading contaminated unleaded gasoline. Laboratory and plant studies are reported. It was found that: the presence of water and high porosity in the impregnated absorber support were essential for effective deleading; non-graphitic carbon impregnated with cupric chloride gave the best results for removing tetraethyl lead from gasoline; silica gel impregnated with cupric chloride was preferred for 1:1 tetramethylethyl lead and tetramethyl lead removal. Studies with impregnated carbon and silica gel systems further showed that: activity was independent of reactor configuration and flow direction; and lead conversion was related to space velocity, operating temperature and contamination level. In addition, service station deleading by a mobile unit was simulated with a recycle system which was highly effective for both carbon and silica gel supports. Product quality studies and a one-year automobile field test demonstrated that the treated gasoline was acceptable for actual use in cars. The deleading process was demonstrated to be feasible on a service station scale.

by A. A. Zimmerman; G. S. Musser; B. J. Kraus; P. E. Godici; J. R. Siegel
Exxon Res. and Engineering Co.
Rept. No. SAE-750695; 1975; 16p 33refs
Presented at the Fuels and Lubricants Meeting, Houston, Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 400

CONTINUOUS MONITORING OF LEAD CONTAMINATION IN UNLEADED GASOLINE

A field test was conducted to study the feasibility of monitoring trace lead in shipments of unleaded gasoline by means of an X-ray fluorescence continuous low lead analyzer. Batches of unleaded gasoline were blended at the refinery and transported to distant terminals by tankers and by pipeline. The low lead analyzer was used to continuously monitor the lead content of the unleaded gasoline as it left the refinery and was received at the terminals. Field data of good precision were in agreement with the accepted atomic absorption method. The standard deviation of the X-ray method is plus or minus 0.0029 grams of lead per gallon and the test repeatability is plus or minus 0.008 grams of lead per gallon. X-ray fluorescence appears to be the best practical method available to determine the average level of lead contamination in large volumes of unleaded gasoline in the field with accuracy and precision. It is concluded that the continuous low lead analyzer is both feasible and practical for determining low lead levels less than or equal to 0.10 grams of lead per gallon in the field provided that it is coupled with a sample preparation system. The sample preparation system should include a filtration system to remove any particulates, a refrigeration unit to prevent butane entrapment, and a coalescer to separate out any aqueous phase. The analyzer can be used to provide an hourly, daily, or monthly record of average lead levels anywhere in the gasoline distribution system. Using these monitoring systems, it was found that a major source of lead contamination of un-

leaded gasoline was from inadequate displacement of leaded gasoline.

by J. B. Angelo; J. R. Siegel; G. S. Musser
Exxon Res. and Engineering Co., Linden, N.J.
Rept. No. SAE-750696; 1975; 12p 2refs
Presented at the Fuels and Lubricants Meeting, Houston, Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 401

EXHAUST SULFUR OXIDE MEASUREMENT USING AIR DILUTION

A method for accurately measuring sulfur oxides in automotive exhaust which involves diluting the exhaust with ambient air and then introducing the mixture into a large bag filled with clean dry air is described. The temperature, pressure, and humidity of the diluted exhaust are measured, as well as the concentrations of hydrocarbons, carbon monoxide, carbon dioxide, sulfur dioxide, and sulfates. Bag concentrations are related to the exhaust by using the sulfur/carbon ratio of the fuel. Established instrumental methods are used for the carbon compounds. The sulfur dioxide in the diluted exhaust gas is measured by the West-Gaeke method, which involves collecting a gaseous sample in a scrubber containing potassium tetrachloromercurate. The sulfates are collected on a particulate filter and measured by a new colorimetric method. Application of these techniques to both non-catalyst and catalyst-equipped cars has shown that: non-catalyst cars emit very low sulfates; under some driving conditions, monolithic catalysts convert a major portion of the fuel sulfur to sulfates at concentrations close to thermodynamic equilibrium; monolithic catalysts can store significant amounts of sulfates, and this storage seems to be temperature related; and driving on a durability route discharges sulfur from the catalyst bed, causing low sulfate emissions for the next 150 miles or so while the catalyst again stores sulfates. It is concluded that different catalyst combinations, even among monolithic catalysts, emit variable amounts of sulfates and that some of these differences may result from temperature variations. It is recommended that more research be conducted into the storage and release of both sulfur dioxide and sulfates.

by M. E. Griffing; L. F. Gilbert; G. Ter Harr; P. A. Immethun; D. W. Zutaut
Ethyl Corp. Res. Labs., Ferndale, Mich.
Rept. No. SAE-750697; 1975; 26p 11refs
Presented at the Fuels and Lubricants Meeting, Houston, Tex., 3-5 Jun 1975.
Availability: SAE

HS-018 402

LEAN COMBUSTION OF METHANOL-GASOLINE BLENDS IN A SINGLE CYLINDER SI ENGINE

Blends of up to 40% by volume methanol in a methanol-gasoline fuel were supplied to a single cylinder engine operating under controlled conditions. Misfire was determined by electronically comparing the peak motor pressure to the peak pressure during engine operation. A continuous sample of the exhaust gas was drawn downstream of a large insulated mixing tank located in the exhaust line. The sample was first passed through an ice bath to remove most of the moisture and then split into a sample to be tested for hydrocarbons and a sample to be tested for carbon monoxide, carbon dioxide, nitric ox-

ides; and oxygen. Methanol blends of up to 20% in the base fuel were found to yield lean misfire limits for each load that occurs at similar equivalence ratio values. For methanol concentrations greater than 20%, the lean misfire limit occurs at leaner values of equivalence ratio than the lean misfire limit for the pure base fuel. Carbon dioxide and oxygen concentrations in the exhaust gas were found not to depend on methanol concentration or manifold pressure, but were shown to be strongly dependent on equivalence ratio. Carbon monoxide content was found to be a function of manifold pressure. Carbon monoxide remained low and did not appear to be a function of increasing methanol in the fuel blend. Nitric oxides did not appear to depend on the amount of methanol in the lean region but was a strong function of equivalence ratio. The maximum brake torque spark advance became progressively independent of the manifold pressure as the methanol concentration increased. The thermal efficiency and torque are higher for the methanol blends than for the pure base fuel. The improved octane number achieved by adding methanol makes it possible to always operate at maximum brake torque throughout the equivalence ratio range between 1.0 and 0.7 methanol blends without being knock limited.

by Edward J. Canton; S. S. Lestz; W. E. Meyer
Pennsylvania State Univ.
Grant EPA-R-802425; EPA-T-900011
Rept. No. SAE-750698; 1975; 13p 21rcfs
Presented at the Fuels and Lubricants Meeting, Houston, Tex., 3-5 Jun 1975. Prepared in cooperation with the Center for Air Environment Studies, Texaco Res. Center, and Champion Spark Plug Co.
Availability: SAE

HS-018 403

CRITERIA FOR CHOOSING AND EVALUATING AERODYNAMIC DEVICES FOR REDUCING FUEL CONSUMPTION OF TRUCKS

A general approach to the decision of a fleet operator to use aerodynamic devices for the reduction of fuel consumption by trucks is outlined. The process by which the decision is reached will involve the use of both equipment performance models and economic models of that equipment. In order to assess the potential of an aerodynamic device for increasing profits, an analytic performance model using experimental data is necessary to provide fuel consumption rates for trip profiles. An economic model must include the trade-off between the purchase price of add-on equipment versus the savings in fuel consumption, the cost of installation, maintenance, cost incurred due to accidents associated with the failure of the equipment, durability of the equipment, and increased or decreased maintenance requirements for other parts of the vehicle as a result of the use of the candidate device. The combination of these two models provides the means through which corporate managers may determine whether a proposed device will improve the profit margin of the company and, if so, it provides a procedure by which competing types of devices can be evaluated for selection. Major considerations in the selection of an aerodynamic device include: the aerodynamic performance of the device, especially with significant cross winds; the structural characteristics of the device with regard to failure model; and whether the device is tractor or trailer mounted. It is noted that the attachment of a device is generally associated with a change in the equilibrium operating speed where the power required equals the power available. This change can significantly reduce the potential fuel savings of the device, especially if it has poor cross wind

behavior. It is relatively difficult to conduct reliable fleet tests, and such tests can be very time consuming while resulting in uncertain conclusions. It is recommended that a controlled test be combined with a realistic appraisal of the changes to be expected in fleet operation. Long term testing should be viewed as a means of verification of the decision to use the device.

by Paul T. Bauer; Ronald A. Servais
Creative Engineering Consultants and Associates
Rept. No. SAE-750701; 1975; 13p 5rcfs
Presented to the West Coast Meeting, Seattle, Wash., 11-14 Aug 1975.
Availability: SAE

HS-018 404

DEVELOPMENT OF DEVICES TO REDUCE THE AERODYNAMIC RESISTANCE OF TRUCKS

A test program to determine the aerodynamic drag of trucks and the development of two add-on devices to reduce drag are reported. The test program involved analytical studies, wind tunnel testing, full-scale field tests, full-scale road tests, and operational testing. A comprehensive instrumentation package designed for testing drag aerodynamic resistance included a propeller anemometer and wind vane mounted on a probe ahead of the vehicle and a specially constructed fifth wheel attached to the rear of the trailer. These devices made it possible to measure ground speed, air speed, and relative wind direction with high precision. It is shown that a dragless state can nearly be achieved with a lip-like device attached to the front face of the van. The shielding effect of one body ahead of another is described and the deleterious effects of cross-flow in the gap between the bodies is discussed. Some add-on devices are particularly susceptible to crosswind flows and lose effectiveness at a few degrees of yaw. The principles of operations of the lip-like device for the front of the truck van and the perforated screen for mounting on the tractor are discussed. These devices have been road tested and were found to give very substantial savings in aerodynamic drag coefficients, exceeding 30% in both cases. The fuel savings associated with such devices depend upon payload, speed, and other operational factors, but can be as much as 60% of the aerodynamic drag savings. The perforated screen appears to be very effective in minimizing crosswind effects and in reducing flow fluctuation and associated buffet. Testing for performance in crosswinds is very difficult, but the crosswind drag performance is of real significance for all truck-type vehicles. These recommended devices appear to function well under crosswind conditions.

by P. B. S. Lissaman
AeroVironment Inc.
Rept. No. SAE-750702; 1975; 12p 5rcfs
Presented at the West Coast Meeting, Seattle, Wash., 11-14 Aug 1975.
Availability: SAE

HS-018 405

AERODYNAMIC DRAG REDUCTION TESTS ON A FULL-SCALE TRACTOR-TRAILER COMBINATION AND A REPRESENTATIVE BOX-SHAPED GROUND VEHICLE

Aerodynamic drag tests were conducted on a full-scale tractor-trailer combination and a box-shaped ground vehicle using the

fast-down method on a smooth, nearly level runway. The tractor-trailer tests included an investigation of drag reduction add-on devices that are commercially available or under development. The box-shaped vehicle was modified by rounding the corners and sealing the undercarriage. The tests ranged in velocity from about 35 mph to 65 mph for the tractor-trailer combination and included fuel consumption measurements and the set of measurements of drive shaft torque. The add-on devices tested on the tractor-trailer combination included: a cab mounted device; a cab mounted device with a 6.5 inch gap between the device and the cab; a trailer mounted device which extended a maximum of 24 inches forward of the trailer; a device mounted on the top front edge of the trailer, with a 6.0 inch gap between the front edge of the device and the trailer and a 1.5 inch gap between the rear edge of the device and the trailer; and a cab mounted device which extended vertically 48 inches above the cab in the stowed position and 38 inches above it in the fully deployed position. The employment and stowage of this last device were automatic and controlled by the impact pressure and its variation with velocity. The maximum aerodynamic drag reduction realized at 60 mph from an add-on device at zero wind conditions was about 24% for the rear trailer position. Some of the add-on devices provided only small reductions in drag. The maximum fuel consumption improvement values realized were about 10% on nearly calm winds. Drag measurements obtained with a laserometer, stopwatch-precision speedometer, and drive shaft torque measurements were consistent with each other. Rounding both the front and rear corners of the box-shaped round vehicle resulted in a 54% reduction in aerodynamic drag at 60 mph as compared with a configuration with all corners square. With the addition of a full-length or three-quarter length underbody seal, the drag reduction increased to 61%.

Louis L. Steers; Lawrence C. Montoya; Edwin J. Saltzman
NASA Flight Res. Center
Rept. No. SAE-750703; 1975; 15p 20refs
Presented at the West Coast Meeting, Seattle, Wash., 11-14 Aug 1975.
Availability: SAE

HS-018 406

COMPARISONS OF EFFECTIVENESS OF COMMERCIALLY AVAILABLE DEVICES FOR THE REDUCTION OF AERODYNAMIC DRAG ON TRACTOR-TRAILERS

Wind tunnel experiments, with emphasis on crosswind effects, have been used to evaluate the effectiveness of a number of commercially available devices for reducing the aerodynamic drag of a tractor-trailer combination. The following types of add-on drag reducing devices were examined: two tractor mounted deflectors, a streamline nose mounted on the trailer front, a corner lip on the trailer front, and a wake stabilizer on the rear trailer front. The wind tunnel models were 1 to 25 scale, with the tractors constructed from commercially available plastic model kits and reinforced to withstand the aerodynamic forces in the tunnel. The evaluation included consideration of the effects of tractor type, trailer height, and the bluffness of the tractor and/or trailers. All tests were performed at a tunnel velocity of 200 mph. The effect of crosswinds was simulated by yawing the model with respect to the tunnel center-

line 55 mph respectively. The wind tunnel measurements of drag and of drag reduction were found to correlate with available full-scale data. The drag of a tractor-trailer combination and the drag reducing ability of a particular device were shown to be a strong function of the yaw angle of the vehicle. The average drag on vehicles equipped with hard-cornered trailers was found to be about 10% higher than for those equipped with soft-cornered trailers, regardless of tractor type or bluffness. The average drag on a tractor-trailer combination is a stronger function of tractor bluffness than of tractor type and decreases with decreasing trailer height. It is suggested that the potential fuel savings from addition of drag reducing devices can range from as low as minus 400 to as high as 3,300 gallons per 100,000 miles, depending on the particular combination of tractor, trailer, and device used.

by Frank T. Buckley, Jr.; William S. Sekscienski
University of Maryland
Rept. No. SAE-750704; 1975; 13p 7refs
Presented at the West Coast Meeting, Seattle, Wash., 11-14 Aug 1975.
Availability: SAE

HS-018 407

WIND TUNNEL DEVELOPMENT OF THE DRAFOILER--A SYSTEM FOR REDUCING TRACTOR-TRAILER AERODYNAMIC DRAG

The development of an effective and practical add-on system for reducing the aerodynamic drag on tractor-trailers--the Drafoiler II--is reported. Wind tunnel tests using 1 to 16 and 1 to 7 scale tractor-trailer models were conducted to determine the empirical design guidelines for the Drafoiler II's side elevation and planform shapes. The Drafoiler system is a detached, three-dimensional forebody for the exposed face of the trailer and is geometrically and aerodynamically integrated with the trailer. Design guidelines have been formulated which configure two different side-elevation profiles, curved and straight, for maximum drag reduction as a function of the tractor roof length and height, gap length, and trailer height. Guidelines for planform shape have also been developed. Zero-yaw drag reductions as high as 30 to 35% were attained. For the combinations of gap length and exposed trailer height investigated, an optimum roof angle tolerance of plus or minus 20% still gave a significant drag reduction of 25%. Baseline configurations were found to suffer large increases in drag with increasing yaw angle. A 50% drag increase at a yaw angle of 10 degrees was typical. A modification of the Drafoiler devised to accommodate roof-mounted air conditioners also solves the interference problem with the center cluster of clearance lamps. The minimum drag coefficient capability was not affected by these modifications, either with or without a roof-air unit. The successful on-road performance of the two-dimensional, original Drafoiler demonstrated the validity of carefully conducted wind tunnel tests with small-scale, simplified models in small wind tunnels. In addition, the one-seventh scale model flow visualization and force measurement test results confirm the appropriateness of the wind tunnel test approach to the problem. The wind tunnel drag measurements confirmed that significant drag reductions are possible with a retrofit device that satisfies all legal and operational requirements. Several Drafoiler IIs have been fabricated in full scale

from fiberglass and are currently undergoing proving ground and commercial fleet evaluation tests.

by William T. Mason, Jr.
General Motors Corp., Res. Labs.
Rept. No. SAE-750705; 1975; 23p 9refs
Presented at the West Coast Meeting, Seattle, Wash., 11-14
Aug 1975.
Availability: SAE

HS-018 408

AERODYNAMIC DEVICES CAN SIGNIFICANTLY REDUCE THE FUEL CONSUMPTION OF TRUCKS: EXPERIENCE WITH CECA DESIGNS

An economic study has been conducted of the relationship between aerodynamic performance and fuel consumption. Experimental wind tunnel evaluation of both new shapes and modified shapes for semi-tractors show that it is possible to both modify existing tractors and to design new tractors which will result in substantial fuel savings. The wind tunnel tests, which used 1/25 scale models, included collecting force and moment data at various yaw angles on several tractor-trailer combinations including cab-over-tractors and conventional tractors, a variety of streamlining modifications to those tractors, and some entirely new tractor shapes. The economic study, which was based on a typical long-haul highway semi-truck operation, demonstrated that aerodynamic drag reduction is related to savings in fuel consumption. The goal of the experimental testing was to design an aerodynamically improved tractor and to then incorporate the critical features of the new design into an add-on device. Although improved aerodynamic performance is easily attained in the absence of crosswinds, typical over-the-road conditions involve crosswinds on the order of 10 mph. In order to produce a net savings in fuel consumption, an aerodynamic device must significantly reduce drag for all typical wind conditions. Closing or filling the gap between the back of the tractor and the front of the trailer was found to produce significant fuel savings in the presence of large crosswinds. A new add-on aerodynamic drag reduction device made of a nylon-reinforced vinyl or rubber-coated material is discussed. The device acts as a large bag which inflates as the truck moves forward, controlling the flow of wind over the top of the tractor and minimizing the cross-flow between the tractor and the trailer. Dynamic tests were conducted using 20% scale models. A variety of materials and bag shapes were evaluated. Full-scale tests were run following the selection of a bag design in order to confirm that the proper shape for the bag was achieved. Prototype tests have led to improved methods for mounting the bag and have not uncovered any major problems. Full-scale tests using a hill-rolling technique demonstrated results consistent with the anticipated performance based on the wind tunnel tests.

by Ronald A. Servais; Paul T. Bauer
Creative Engineering Consultants and Associates
Rept. No. SAE-750707; 1975; 9p 1ref
Presented at the West Coast Meeting, Seattle, Wash., 11-14
Aug 1975.
Availability: SAE

HS-018 409

AN OVER-THE-ROAD FUEL ECONOMY TEST

An over-the-road fuel economy test was developed which yields a true reflection of fuel consumption for the everyday road user. The test is designed to provide a uniform over-the-road fuel economy test of light duty vehicles under 6,001 lbs, having a capacity of 12 persons or less. The procedure incorporated all the types of driving that a user would normally encounter. The test route selected includes: not less than 50 miles total distance, divided into segments of not less than 25 miles outgoing and with return on the same route; references made to the nearest airport to obtain information on the prevailing wind direction and weather conditions; and route selection to allow the car to be subjected to the prevailing winds on all sides and in nearly equal proportions. The test route includes a city driving cycle, an urban driving cycle, a suburban driving cycle, a freeway driving cycle, and a hill climbing cycle. The instrumentation selected to achieve repeatability, reliability, and accuracy included: a portable tape recorder; a test fuel tank made of light weight aluminum and with a capacity of 9 gallons; a potentiometer; a power inverter; a digital read-out timer; a tachograph with the capability of recording speed, running time, acceleration time, periods of idle, engine shut-off time, and mileage; a portable bi-metallic hygrometer; a revolution counter; a heavy duty solution balance; a hygrometer with built-in thermometer; a barometer; and automotive diagnostic instrumentation. During the baseline tests to establish the variables which might affect results, the driver verbalized each landmark or change of attitude of the vehicle, using common road markers as guide posts. When played back about 5 to 30 seconds ahead, the tape recording could direct the test driver to repeat each variation during the device test as it was done on the baseline. Where driving conditions prevented exact duplication, the observer could use the digital timer to record the time/speed space of the deviation and inform the driver so that the appropriate compensation could be applied to resume the baseline time frame. It is suggested that this test procedure can enable a manufacturer of an add-on device to have tests conducted within a reasonable cost.

by Alexander Carr
Carr Engineering
Rept. No. SAE-750726; 1975; 8p 7refs
Presented at the West Coast Meeting, Seattle, Wash., 11-14
Aug 1975.
Availability: SAE

HS-018 410

DESIGN AND DEVELOPMENT OF THE CATERPILLAR 7155 SEMI-AUTOMATIC HEAVY- DUTY TRUCK TRANSMISSION

The design and development of a semi-automatic, pneumatically controlled, constant mesh transmission for the Caterpillar 7155 is discussed. The 7155 Transmission is a 16 forward, two reverse ratio, semi-automatic, quick shifting mechanical drive transmission designed for heavy-duty trucks. The driver controls the shift initiation and gear ratio selection by moving the selector lever in the truck cab. The shift is made automatically when an air pressure signal is sent from the ratio selector to the transmission control group. Laboratory evaluation of potential components centered around the development of the pneumatic controls, gear couplings, and means to connect and

was performed on a test setup which included a 270 horsepower engine, a 7155 transmission, and an eddy current absorption dynamometer. A drive train simulator was used for precise testing of components and of the system. The drive system mechanically simulates the mass-elastic system of a loaded truck and its motion resistance as reflected to the transmission output shaft. The setup includes a ratio selector which is positioned by cylinders to simulate driver's motions. The control console includes the programmer; indicators for speeds, pressures, and temperatures; torque indicators for both drive shaft and dynamometer torques; and the safety shut-down annunciator. An extensive field testing program included the installation of 12 experimental units in customer-owned trucks. Since the gears do not dip in the lubricating oil and oil pressure is not used for the controls, the only loss associated with oil is the small lubricating pump. With this small loss level, the mechanical efficiency is greater than 95%, eliminating the cost and installation of an oil cooler and lines. The design for use with engine oil and "top of frame" oil checking and filling improves the serviceability and maintenance needs of the 7155 Transmission. The incorporation of fingertip shifting controls and no clutch pedal starting has increased the ability of unskilled drivers to use the transmission and reduced the effort and concentration required of accomplished drivers.

by Philip S. Webber; Harry B. Newman
Caterpillar Tractor Co.

Rept. No. SAE-750729 ; 1975 ; 20p

Presented at the West Coast Meeting, Seattle, Wash., 11-14 Aug 1975.

Availability: SAE

HS-018 411

AN AUTOMATIC TRANSMISSION IN LINE HAUL VEHICLES AFTER TWO YEARS OF FLEET EVALUATION

The results of an extensive fleet evaluation of the Allison HT 750-CRD model automatic transmission in line haul vehicles are reported. The HT 750-CRD transmission incorporates a three-element torque converter. The gear package of the transmission consists of six clutch packs and three constant mesh planetary gear sets. The hydraulic control, which makes the transmission automatic, receives two signals--an internal governor signal proportional to transmission output speed and an external signal of engine throttle position. A survey of line haul fleet operators prior to the production release of the HT 750-CRD indicated that there was a high interest in the automatic transmission as a solution to manual transmission related problems. The fleet evaluation program was designed to obtain vehicle operating and maintenance costs for both automatic and manual equipped line haul vehicles throughout their normal lives and to determine the acceptability of the automatic transmission in line haul service. The 27 fleets in the program are represented by a total of 12 vehicles utilizing 15 different engines and operate under a variety of geographic and climatic conditions. The manual transmissions to be compared to the HT 750-CRD were chosen by the management of each representative fleet, but the majority are the 10-speed transmission type unit. Evaluation of operating experiences has indicated that the concept of the HT 750-CRD appears to be correct for an automatic transmission in a line haul type vehicle. Preliminary data shows that the automatic transmission contributes to reduced maintenance costs. However, in order to fully appreciate the savings from the automatic transmission

more time must be allowed for fleet tractors to complete most of their expected lives. Transmission refinements to improve fuel economy are being investigated. In addition, refinements in converter changes, changes in the 3-4 shift valve, and shift quality improvements are being tested in order to extend the life of the transmission and to improve its performance and shift smoothness. The fleet testing has generally resulted in favorable response from both fleet managers and truck drivers.

by E. R. Cottingham

General Motors Corp., Detroit Diesel Allison Div.

Rept. No. SAE-750730 ; 1975 ; 14p

Presented at the West Coast Meeting, Seattle, Wash., 11-14 Aug 1975.

Availability: SAE

HS-018 412

THE SNAPPER, DESIGN AND DEVELOPMENT OF A SELF-ENGAGING MECHANICAL TRANSMISSION

A new concept of a mechanical transmission has been developed using engine synchronization and frictional blockers to control engagement. This transmission's uniqueness stems from its self-engaging characteristics, which impart an ease of shifting coupled with immunity from driver abuse. The transmission, named the Snapper, is now in the early stages of production following about 6 years of development. The main design features of the first Snapper developed included: Roadranger twin countershaft configuration with four-speed front section and two-speed rear section; sliding mainshaft gears in front and rear sections; main section gearing tied in permanently with the input shaft; rear section gearing tied in permanently with the output shaft; spring loaded jaw clutches; pull type master clutch with input brake; anti-friction thrust bearings on the mainshaft; and rear section gearing shifted pneumatically with a two-position valve and air cylinder. The second generation Snapper developed following testing of the original model had the following major features: four-speed sliding gear with wide step front section plus reverse; unblocked first speed gear with spring force and clutch weight tailored for smooth engagements; remaining front box gears with spring engaged clutches and bidirectional blockers, which travel axially with the gears and circumferentially with the clutches; rear section three-speed, sliding gear, splitting the front box ratios and providing 12 evenly spaced, progressive steps from 11.3 to 1 first gear to direct; rear section gears having bidirectional blockers; rear section gearing which shifts pneumatically through use of a three-position control valve and two shift cylinders; and input provided with a controlled force brake for stopping the transmission input element for initial engagements and slowing the transmission input element for fast upshifts. A vehicle mission simulation (VMS) program was utilized in designing this transmission. Characteristics of the transmission operating and driving techniques are outlined. It is concluded that this transmission provides many of the advantages of an automatic transmission with little of the penalty in cost or complexity.

by Edward J. Bogema; John R. Vandervoort

Eaton Corp., Transmission Div.

Rept. No. SAE-750731 ; 1975 ; 13p

Presented at the West Coast Meeting, Seattle, Wash., 11-14 Aug 1975.

Availability: SAE

APPLICATION CONSIDERATIONS WITH THE CUMMINS SUNDSTRAND DMT-25 HYDROMECHANICAL TRANSMISSION

A fully automatic hydromechanical transmission has been successfully applied in a variety of heavy duty trucks and is now being offered by numerous truck manufacturers. In 1971, the DMT-25 hydromechanical truck transmission was removed from the engineering laboratory and test track environment and placed in actual field operations. The field test program, implemented to seek out and correct hardware deficiencies and to gain vehicle application experience, involved equipping 52 vehicles with the transmission. Factors taken into consideration in the tests included: geographic and climatic conditions; various makes and models of diesel and gasoline engines; primary industry segments, such as refuse, dumper, mixer, highway tractors, and urban trucks; vehicle duty cycles and load factors; and gross vehicle weight ratings. These field tests demonstrated that the DMT-25 transmission offered the following advantages: it was extremely abuse tolerant; engine, engine accessory, driveline, axle, and brake problems tended to be reduced; fuel economy in most applications equalled or bettered the fleet average; and vehicle productivity showed improvement, particularly in urban and suburban operations. One unique characteristic of the DMT-25 transmission is the inherent ability to develop full output torque for vehicle start-up while drawing a minimal amount of engine power. Another characteristic is that input speed matching to a specific engine model is done by means of an input gear mesh, which ensures that the variable displacement hydrostatic unit will operate in an optimum speed range. The hydromechanical transmission is an infinitely variable loading device which controls engine speed and power in the operating range between low and high idle in response to signals from the engine fuel governor position and from the transmission. The transmission infinitely varies ratio based on comparing these two signals. The infinitely variable ratio characteristic offers the engine designer a new approach for the development of an optimum power package which combines relatively constant power output with greater fuel economy, lower engine noise, and lower engine emissions. Volume production of the DMT-25 transmission began in 1973, and over 1,500 of the units have now been produced for the industry.

by Paul E. Troin; Vic G. Gostomski
Cummins Sundstrand, Inc.; Sundstrand Corp., Hydro-Transmission Div.
Rept. No. SAE-750732; 1975; 12p 1ref
Presented at the West Coast Meeting, Seattle, Wash., 11-14 Aug 1975.
Availability: SAE

HS-018 414

LABORATORY TESTING MACHINES AND PROCEDURES FOR MEASURING THE STEADY STATE FORCE AND MOMENT PROPERTIES OF PASSENGER CAR TIRES

Equipment and methodology for measuring the steady state properties of free-rolling passenger car tires are described and discussed. Specific recommendations are made for space, measuring system ranges, and accuracy needed to measure the force and moment properties of the full range of passenger car tires. The equipment consists of a tire force and moment machine composed of the following units: a flat moving sur-

face used to simulate the road; a mechanism for positioning the tire-wheel assembly and allowing for adjustment of normal force, slip angle, and inclination angle; and a weighing system to facilitate measurements of force and moment components. A typical test includes six or more vertical loads in uniform increments from about 40% through 160% of rated load. To make it easier to compare the performance of tires which are subjected to different load carrying demands, the principal size and weight effects were removed by dividing the observed tire properties by a load or size factor. The load used must be representative of the mean operating load at which the tire would normally be used. Two stages of transducer data processing are usually required with the tests. First, transducer calibration and interaction data are used to calculate the transducer output forces for a particular set of conditions and these forces are then used to calculate the force and moment components. The data are then configured for tabulation and/or plotting. The basic form for presentation of complete force and moment data are plots of each variable as a function of load and angle (slip or inclination). Carpet type plots are frequently used to provide a compact format that is easily read and interpolated.

Society of Automotive Engineers, Vehicle Dynamics Comm.
Rept. No. SAE-HS-210; SAE-J1106; SAE-J1107; 1975; 35p 61refs
Includes (SAE-J1106), Recommended Practice and (SAE-J1107), Information Report.
Availability: SAE

HS-018 423

SOME DATA ABOUT TRAFFIC AND ROAD ACCIDENTS

Statistics on the following aspects of Swedish traffic are presented in graphs, charts, and tables: registered vehicles; gasoline consumption; road construction; accidents by frequency, damage/injury, injury severity, type, time, road and weather conditions; license issuance and revocation; traffic offense imprisonments; and fatalities by frequency, time, category of road user, and sex and age. Vehicle registration and fatality statistics for certain countries other than Sweden are included. Statistics go as far back as 1950 and most cover a time period up to 1972.

by Stig Alexandersson; Thomas Lekander
Swedish Road Safety Office, Devel. Section, P.O. Box S-171 20 Solna 1, Sweden
1973; 45p refs
Availability: Corporate author

HS-018 424

A QUASI-CLINICAL STRATEGY FOR SAFETY RESEARCH: A CASE-STUDY OF ATTITUDES TO SEAT BELTS IN THE CITY OF REGINA, SASKATCHEWAN, CANADA

A sample survey/interview of 465 people (198 males and 267 females) selected from a random sample of 600 households in Regina, Saskatchewan, Canada, and representative of the general population was conducted to determine the underlying causes of the public's resistance to safety belts, and the implications for attitude change in this area, and to develop and validate a research strategy for investigating patterns of public behavior in common social situations. Previously, interviews

were conducted with various experts or opinion leaders in the area of traffic safety, three groups of 12 subjects drawn from an opinion sounding panel maintained by the University of Saskatchewan at Regina, and a small, stratified sample of some 50 people selected to be representative of the population of Regina. The underlying aims and rationale of the study are explained, traditional ways of assessing public opinion are critically examined, relevant research on automobile safety and safety belts is reviewed, and the research and study methodologies are described. Findings suggest that firm instructions to fasten safety belts, along with direct supervision that it had been done, would yield a high proportion of seat belt usage in motor vehicles. Respondents almost universally reported that, if they were a passenger in a car and the driver told them to fasten their belts, they would do so without argument. The major recommendation put forward for increasing safety belt usage is that the decision whether to buckle up or not should be taken out of the hands of the individual motor vehicle user. Literature used in the survey/interviews is appended.

by Chris K. Knapper; Arthur J. Cropley; Robert J. Moore
University of Saskatchewan Regina Campus, Dept. of
Psychology, Saskatchewan, Canada
1973 : 277p 77refs
Sponsored by the Canadian Dept. of Transport.
Availability: Reference copy only

HS-018 429

CONTROL OF MOTORCYCLE NOISE. VOL. 1. TECHNOLOGY AND COST INFORMATION. FINAL REPORT

A study was conducted to determine the estimated manufacturing cost increases which will be necessitated by the reduction of noise from future motorcycle models. Most of the data used in the study was available from motorcycle manufacturers, including information on the prices and noise levels of 1971, 1972, and 1973 models; information on particulars of noise from various specific sources within the motorcycles (including exhaust, intake, engine, drive system, tires, vibration, and wind); the company noise reduction timetable for implementing modifications; and the expected manufacturing cost changes occasioned by the modifications. Supplemental information was obtained from exhaust system and accessory manufacturers, industry organizations, independent motorcycle journals, and independent organizations which have performed motorcycle noise measurements. The study results show that, although significant reductions in noise from production motorcycles sold in the United States have been effected since 1969, further substantial reductions are possible. Treatment principally of intake and exhaust noise has brought large motorcycles within the 1973 California State noise regulations and has been responsible for certain performance decreases and production cost increases of up to 5% of prereregulation levels. The major manufacturers are now striving toward meeting the stricter 1975 California standards for large machines through the addition of mechanical noise treatments and further improvements in intake and exhaust silencing. It is concluded that it is within industry capability to reduce the noise levels of about 50% of the motorcycles over 200 cubic centimeters (cc) displacement to the new standards by October 1975, with an average cost increase of \$28.00 per machine; to reduce the noise levels of about 75% of the machines with engine displacements between 100 and 200 cc to new requirements with a per machine cost increase of \$19.00; and to

reduce the noise level of about 75% of the under 100 cc machines for about \$5.00 more per machine. Performance of the motorcycles could further diminish more than 5% and general industry predictions of fuel consumption increases range as high as 10%.

by Steven R. Skale; Ben H. Sharp
Wyle Labs.
Contract EPA-68-01-1537
Rept. No. 550/9-74-001-A; 1974; 130p 14refs
Availability: NTIS; Environmental Protection Agency, Office
of Noise Abatement and Control, Arlington, Va. 20460

HS-018 430

AN OPERATOR'S GUIDE TO SAFE AND ENJOYABLE BICYCLING

A basic guide for the safe operation of a bicycle is presented. Topics covered include: the rules of the road (the basic speed law, signs, signals, pavement markings, road signs, right-of-way, turning and signaling, passing and being passed, side-walks, crosswalks, crossing guards, and special situations and vehicles); defensive bicycling techniques (intersection phenomena, and road hazards); the bicycle as a machine (required and optional equipment, and maintenance); registration and theft protection; walking the bicycle; bike routes (laws and rules, and location of bike lanes with map); and recreational and group rides. Drawings illustrate the information of the text.

San Jose Dept. of Public Works, Bicycle Safety for Santa
Clara County Project
1974 : 32p

Supported by a Highway Safety Project Grant provided by the Governor's Office of Traffic Safety, and by the City of San Jose's Public Works Department.
Availability: Reference copy only

HS-018 431

WHAT TO DO WITH THE EXTRA PART WHEN YOU'RE ALL FINISHED. A GUIDE TO BIKE REPAIR AND MAINTENANCE

A guide to understanding proper bicycle maintenance and making some basic repairs is presented. Topics discussed include: adjusting the bike for the individual; truing the wheels; tires; brakes (hand and coaster brakes); 1-speed, 2-speed, and 3-speed mechanical maintenance and care; 10-speeds (purpose and cadence, shifting and levers, adjusting, care and sundries); bearings (crank bearings, wheel bearings, headset, pedals, and lubricating the chain); and accessories. Drawings illustrate the text.

by Bob Shanteau; Bob Jones
n.d. ; 17p
Supported by the State of California Office of Traffic Safety and the National Hwy. Traffic Safety Administration.
Availability: San Jose Public Works Dept., Bicycle Safety Project for Santa Clara County

HS-018 432

SCATTER LIGHT IN THE MAIN FIELD OF VISION AND SPEED

Laboratory tests were designed to determine the time span which passes during blinding by oncoming light. The laboratory conditions involved setting low beam headlamps in the direction of travel and measuring the time which passed before obstacles, appearing on the road at the same time as the glare, were perceived. The obstacles, which included the picture of a dog and of a box of equal size and a pedestrian, were located at a distance of 131 to 164 feet in front of the observer. The oncoming light was a low-beam lamp which was turned on for 2 seconds and then turned off. The experimental set-up simulated two cars approaching each other at a mutual speed of about 37 mph. The scattering contributions of four windshields placed between the glare source and the driver and the effects of various angles of declination of these windshields were also tested. Subjects included 10 drivers with normal vision under age 40, 10 drivers with normal vision over age 40, and 10 drivers wearing glasses. Average perception delays were in no case less than 1.67 seconds. Older drivers without glasses generally had a longer delay time than younger drivers. Drivers wearing glasses demonstrated an average perception delay of 2.45 seconds. Perception delays were lowest with the 30 degree angle of declination for the windshields; a declination in excess of 40 degrees led to disproportionately large increases in the perception delays. The influence of the scatter light increases with the number of miles driven through small impact damages and scratches in the windshield.

by Walter Schneider
1977; 6 refs

Text also in German.

Availability: Reference copy only

HS-018 433

PEAK WET BRAKING COEFFICIENT MEASUREMENT

The effect of brake application time and data filtering frequency on peak braking coefficient measurements was investigated. The tests were performed on a passenger car using the vehicle deceleration method, with the rear brakes deactivated. Measurements were made on three test surfaces of very low, medium, and high skid textures. Test procedures were essentially in accordance with the American Society for Testing and Materials standard for Testing Tires for Wet Traction in Straight-Ahead Braking Using Highway Vehicles (F 403-74), which consists of measuring the deceleration of the vehicle with an accelerometer mounted on the transmission tunnel while braking with the front wheels only. An adjustable needle valve is inserted in the front brake line to provide accurate and repeatable control of the application rate. The test results demonstrate that the rate of brake application does not affect the peak braking coefficient of a passenger car tire for brake application times up to about 1.0 seconds to peak. The filtering frequency was shown to be very critical in obtaining accurate peak coefficient measurements; it must be set low enough to exclude extraneous inputs and high enough to provide sufficient response. The lower limit is dependent on the brake ap-

plication time--the shorter the brake application time, the higher the low frequency limit.

by C. F. Beauregard

Publ: Tire Science and Technology v4 n1 p49-55 (Feb 1976)

Availability: See publication

HS-018 434

INFLUENCE OF WHEEL ANGULAR DECELERATION RATE ON PEAK BRAKING FORCE ON WET ROADS

The peak braking force produced by six tires was measured on three wetted surfaces at five different wheel lockup rates. The test program consisted of gathering peak braking force data with the Highway Safety Research Institute mobile tire tester on six different tires on the three surfaces at 40 mph. The water depth was about 0.02 inches. The test surfaces were pads consisting of a portland cement concrete surface, a jennite-covered asphalt surface, and a crushed gravel hot asphalt. The test results demonstrate that the mean value of maximum braking force generated by passenger car tires on wet road surfaces can be significantly affected by wheel angular deceleration rate. However, it is not possible to quantify this statement due to the rather small amount of data collected in this study. Much more data is needed in order to accurately define the effects of wheel angular deceleration. It appears that the lockup rate is a variable which should be considered in measuring the maximum or peak braking force. Results of the test program are tabulated.

by R. E. Wild

Publ: Tire Science and Technology v4 n1 p36-48 (Feb 1976)

Availability: See publication

HS-018 435

WET BRAKING TRACTION VALIDATION

The Safety Research Laboratory of the National Highway Traffic Safety Administration conducted a series of low wheel tests to collect wet traction data on a sample of tires in order to develop a data base for establishing traction standards. Identical tests were run on three surfaces at the Transportation Institute (TTI) and on two surfaces at the Uniform Tire Quality Grading Treadwear and Traction Facility at Goodfellow Air Force Base (GAFB) in San Antonio, Texas. The test surfaces used included a hot-mix asphalt concrete, and a clay-filled tar emulsion (jennite). Forty pairs of 1973 commercial passenger car tires and one pair of racing slicks were selected for the tests at TTI. Seventeen of these pairs were tested at GAFB. The precision of the results demonstrated the feasibility of using a two-wheel skid trailer for locked wheel tire traction grading and of constructing surfaces which will remain stable for the purpose of traction testing. Data generated by the testing is presented.

by A. H. Neill, Jr.

Publ: Tire Science and Technology v4 n1 p16-35 (Feb 1976)

Availability: See publication

August 31, 1976

HS-018 436

ENERGY LOSS OF PNEUMATIC TIRES UNDER FREELY ROLLING, BRAKING, AND DRIVING CONDITIONS

The concept of rolling resistance force for pneumatic tires is replaced by that of energy dissipated in unit distance traveled. The energy loss per unit distance, which is a function of slip angle, inclination angle, wheel torque, and other variables, is shown to reach a minimum under driving conditions, not under freely rolling conditions which was assumed in rolling resistance calculations. The new formula is compared with previously developed formulas for rolling resistance.

by D. J. Schuring

Publ: Tire Science and Technology v4 n1 p3-15 (Feb 1976)
1976; 5refs

Availability: See publication

HS-018 437

IMPROVED FUEL ECONOMY FOR AUTOMOBILES

A variety of measures that offer potential for improvement of fuel economy in all sizes of cars are identified and discussed briefly. All of the measures identified could be achieved under the current state of the art. Although some of the measures would increase the price of the automobile, it is suggested that these price increases would become more acceptable as fuel becomes more scarce. The measures discussed include: varying the compression ratio in the engine; improving the distribution of the fuel-air mixture to the cylinders; a better explosion, especially of lean mixtures, achieved through the use of two spark plugs per cylinder that fire at different points in the cycle; reduction of internal friction; reducing pumping losses through an arrangement in which a positive displacement blower is placed ahead of the intake manifold and transfers power to the engine by making the intake air do work in the process of undergoing a pressure drop; faster warmup through transferring the exhaust heat to the coolant; elimination of idling; improvement of transmissions to cause the engine to operate at the lowest possible speed at which it can deliver the needed power; switching to spiral-bevel gears on the rear axle; emphasizing low rolling resistance in tires; and reexamination of current air conditioning methods. It is suggested that a government-sponsored research program, completely independent of the automobile industry, is needed to investigate these potential fuel economy options.

by Charles E. Cohn

Publ: Technology Review v77 n4 p44-52 (Feb 1975)
1975; 16refs

Availability: See publication

HS-018 438

REDUCING THE ENERGY INVESTMENT IN AUTOMOBILES

Possibilities for reducing the energy requirements of automobiles are considered. The energy needed to build and to fuel automobiles is discussed. Particular emphasis is given to weight reduction as a source of energy savings. Reducing the

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sumption. This would be a savings greater than the amount of petroleum currently imported by the U.S.

by John K. Tien; Roy W. Clark; Mahendra K. Malu

Publ: Technology Review v77 n4 p38-43 (Feb 1975)
1975; 4refs

Availability: See publication

HS-018 439

THE AUTOMOBILE AS AN ENERGY CONVERTER

Some of the principal factors that affect the efficiency of gasoline usage by the automobile are examined. The following topics related to modern internal combustion engines and their low fuel economy are discussed: transmissions and economy; combustion and fuel savings; pollution constraints (controlling nitrogen oxides, carbon monoxide, and hydrocarbons); homogeneous oxidation using a thermal reactor approach; catalytic exhaust gas treatment; alternate power plants (the gas turbine engine, the Stirling engine, and the fuel cell); and energy storage and recovery. While the thermal efficiency of the Otto cycle internal combustion engine is good (about 35%) when used at high power levels, the fuel economy is degraded considerably by part-load operation, the convenience of accessories, and high vehicle weight. It is these factors that must be attacked to produce better fuel economy, for a great deal of development will be required to make modified and alternative engines practical. Research has shown that improvements in fuel economy are indeed feasible, and that much research and development has already been done on them. However, in many cases, engineering developments that can lead to a better fuel economy await the arrival of sufficient economic benefit to offset their initial cost.

by Joseph T. Kummer

Publ: Technology Review v77 n4 p26-37 (Feb 1975)
1975; 5refs

Availability: See publication

HS-018 440

HOW SAFE IS SMALL? [LIGHTWEIGHT CARS]

The effects of smaller, lighter cars on traffic safety are discussed. Although small cars are not unsafe simply because they are small, they can be at a disadvantage in car-to-car collisions. The occupants of the lighter vehicle will be subjected to a greater deceleration than the occupants of the heavier vehicle, and must, therefore, make a greater effort to protect themselves. Available data indicates that small cars have between a 20% and 35% chance of becoming involved in a collision with a large, heavy car, given that the small car is in an accident. As the trend toward smaller, lighter vehicles continues, there will be progressively less chance of small cars colliding with large, heavy cars. Available accident statistics do not demonstrate conclusively that the risk of injury in an accident is greater in a small car than in a large one. It is concluded that as more people shift to small cars, the roads can be expected to become progressively safer for small cars, since the chances for accidents involving collision with large

cars will decrease. The discussion is presented in a speech format.

by David E. Martin
General Motors Corp., Automotive Safety Engineering
1976 ; 15p 12refs
Presented at the 24th Annual Safety Conference of the
Dayton-Miami Valley Safety Council, Dayton, Ohio, 24 Feb
1976.
Availability: Corporate author

HS-018 441

**TRAVEL PATTERNS AND PROBLEMS OF
SUBURBAN HIGH SCHOOL MALES:
EXPLORATORY STUDY OF THE PHYSICAL
MOBILITY OF A POPULATION SUBGROUP, WITH
RECOMMENDATIONS. SUMMARY OF THE FINAL
REPORT**

by Douglas B. Gurin
Harvard Univ., Cambridge, Mass.
Contract DOT-FH-11-7849
1974 ; 47p 32refs
Partially supported by the National Science Foundation. For
abstract, see HS-018 442.
Availability: Department of Transportation, Assistant
Secretary for Policy, Plans and International Affairs; Federal
Hwy. Administration, Socio-Economic Studies Div.,
Washington, D.C.

HS-018 442

**TRAVEL PATTERNS AND PROBLEMS OF
SUBURBAN HIGH SCHOOL MALES:
EXPLORATORY STUDY OF THE PHYSICAL
MOBILITY OF A POPULATION SUBGROUP, WITH
RECOMMENDATIONS. FINAL REPORT**

Teenager responses to transport supply changes are forecast and explained by comparing the behavior, needs, and preferences of similar youth from three working class Boston, Massachusetts, suburbs who had varying transit and automobile resources. Most information came from a representative sample of 50 volunteers who met in weekly panels to detail their socio-economic attributes, available transportation, trip-making, and spending. Teenagers' perceptions of travel motivations and their economic, social, and psychological difficulties with transportation were offered. Panelists' trip generation rates seemed independent of transit availability. Rates averaged about 9.6 pedestrian and vehicle trips per day in each study suburb. Transit use among the sample's 24 unlicensed teenagers seemed to rise with maturity and desires for non-neighborhood travel; transit accounted for 11% of panelists below driving age, while those old enough to drive used transit on 18% of their trips. Transit use was restricted primarily to predictable, long distance trips to school and home. Licensed and unlicensed panelists rode as passengers in informal carpools on about 18% of their trips, with friends providing more than two-thirds of these rides. Transportation expenditures reflected teenager travel desires and perceptions of parental and community willingness to provide transportation which permitted offpeak and unchaperoned travel for such important and complex trip purposes as dating and part-time employment. Maturing working class travelers with high travel motivations, desires for self-reliance, or pessimistic perceptions of adult assistance wanted or felt compelled to secure

their own transportation, even at high cost. The sample's 11 car owners chose to spend 47% of their budgets on transportation, mostly for automobiles. A bibliography and methodological appendixes provide detailed guidance to plan and evaluate exploratory subgroup research using consumer panels, tape recordings, and self-administered survey forms such as trip, telephone and budget diaries. The quality of the study and published information is reviewed by teenagers and professionals from many disciplines.

by Douglas B. Gurin
Harvard Univ., Cambridge, Mass.
Contract DOT-FH-11-7849
1974 ; 635p 256refs
Summary rept. is HS-018 441.
Availability: Department of Transportation, Assistant
Secretary for Policy, Plans and International Affairs; Federal
Hwy. Administration, Socio-Economic Studies Div.,
Washington, D.C.

HS-018 443

**DYNAMIC METHOD FOR STORAGE BATTERY
DIAGNOSTIC TESTING**

A technique for field testing storage batteries by which the battery's dynamic conductance is sensed electronically using a time varying signal is described. The dynamic conductance is proportional to the maximum power available and provides a direct measure of the battery's overall condition. Since large currents are not required, the testing apparatus can be small and lightweight. Moreover, dynamic measurements are instantaneous, unaffected by polarization, and can be routinely performed without perturbing the battery. An electronic battery tester embodying the dynamic measuring technique is described. This device provides either an absolute determination of maximum power available at the battery terminals, or a "pass-fail" assessment based on the battery's rating and temperature. Comparisons are made between dynamic and load test measurements at both 70°F and 0°F, and a high degree of correlation is observed. The effects of battery size, temperature, charge, and polarization are discussed. Specific uses of the dynamic measuring technique are proposed which take advantage of its inherent reproducibility, accuracy, and facility.

by Keith S. Champlin
University of Minnesota, Electrical Engineering Dept.
Rept. No. SAE-750758 ; 1975 ; 13p 4refs
Presented at the SAE Off-Highway Vehicle Meeting,
Milwaukee, Wis., 8-11 Sep 1975.
Availability: SAE

HS-018 444

**DIRECT UTILIZATION OF CRUDE OIL AS A FUEL
FOR HIGH-SPEED DIESEL ENGINES**

Crude oils with a wide range of properties were investigated for direct use as fuel in United States (U.S.) Army high-speed four-cycle diesel engines. Crude oil properties were divided into two groups: those properties which would be of importance for short-term operational effects; and those properties whose effects would manifest during longer-term operation. Effects of crude oil use on engine subsystem hardware such as fuel filters and fuel injection pumps were investigated. Performance and combustion data were determined using pre-cup and direct injection configurations of the single cylinder CLR diesel engine operating on various crude oils. Per-

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formance, wear and deposition effects of crude oil use were obtained using the TACOM single cylinder diesel engine. Results of this investigation showed that a wide range of crude oils with proper selection and pretreatment are feasible emergency energy sources for U.S. Army high-speed four-cycle diesel engines. In fact, any heavy hydrocarbon fluid that burns and meets the handling criteria outlined could be considered as a potential nonstandard fuel. For example, motor oils or heavy residual fuels diluted with distilled fuels would be expected to yield short-term results similar to those observed with crude oils.

by E. C. Owens; E. A. Frame; Walter Bryzik
Army Fuels and Lubricants Res. Lab.; Southwest Res. Inst.;
Army Tank Automotive Command
Rept. No. SAE-750762 ; 1975 ; 12p 21refs
Presented at the SAE Off-Highway Vehicle Meeting,
Milwaukee, Wis., 8-11 Sep 1975.
Availability: SAE

HS-018 445

PERFORMANCE SIMULATION OF A DIESEL PISTON AND RING SYSTEM

Analytical models of piston movement, gas flow in the ring belt, and piston ring movement are described and integrated to form a system simulation which was implemented on a digital computer. Sample computer solutions are given to illustrate the models' usefulness in predicting the effect of design and operating variables upon specific performance characteristics. Suggested refinements to the system model are also discussed. The need for a ring face hydrodynamic oil film analysis which considers ring tilt and lateral loading of the ring by groove friction.

by G. R. Bishop; A. H. Leavitt
John Deere Waterloo Product Engineering
Rept. No. SAE-750768 ; 1975 ; 11p 29refs
Presented at the SAE Off-Highway Vehicle Meeting,
Milwaukee, Wis., 8-11 Sep 1975.
Availability: SAE

HS-018 446

METHANOL/GASOLINE BLENDS AS AUTOMOTIVE FUEL

A study was conducted to determine the effect of the addition of methanol to conventional gasoline on exhaust emissions and fuel economy. Ten 1974 and 1975 model vehicles were used in the study. Ambient temperature was varied from 20°F to 100°F to determine temperature effects while using methanol/gasoline blends. Emissions were generally modified as a consequence of the fact that the addition of methanol to gasoline alters both the fuel vapor pressure and the stoichiometry of the fuel-air mixture. Fuel economy was generally decreased by methanol addition. Moderate mileage accumulation (5,000 miles) using 10% methanol fuel showed no deterioration either in emissions control or of fuel-related engine components. Driveability differences between methanol

10% blends and gasoline were detectable but were judged not to be objectionable.

by J. R. Allsup
Bartlesville Energy Res. Center
Rept. No. SAE-750763 ; 1975 ; 11p 7refs
Presented at the SAE Off-Highway Vehicle Meeting,
Milwaukee, Wis., 8-11 Sep 1975.
Availability: SAE

HS-018 447

DWI PROGRAMS. ARE WE DOING WHAT'S "IN" OR DODGING WHAT'S INDICATED?

The weaknesses of different rehabilitation programs and the problems involved in dealing with the driving while intoxicated (DWI) driver are considered. The Phoenix programs, in particular, are criticized as at best only a set of countermeasures that might have a beneficial effect on one small part of the DWI population. Programs that combine lower blood alcohol standards with vigorous, widespread, and uniform enforcement are needed.

by Paul C. Whitehead
Publ: Traffic Safety v76 n3 p20-1, 36 (Mar 1976)
1976
Adapted from a paper published in NSC's Journal of Safety Research.
Availability: See publication

HS-018 448

LOWEST DEATH RATE EVER

An extensive analysis of 1975 motor vehicle deaths, comprising the lowest death rate on record, is presented. The following characteristics, statistical information, and factors involved in these fatalities are analyzed: travel, vehicles, drivers in 1975; the death rate; turnpike experience; injuries; factors affecting traffic deaths in 1975; regional changes; urban-rural fatality experience; deaths by age of victim and type of accident; and state and city experience (with complete statistics on 1973-1975 deaths in 627 cities and towns and all 50 states). The largest regional percentage decrease in deaths (6%) occurred in the South Atlantic states. A total of 27 states showed decreases in fatalities in 1975.

by J. L. Recht; Barbara Carraro
Publ: Traffic Safety v76 n3 p14-6, 28-33 (Mar 1976)
1976
Availability: See publication

HS-018 449

GLASS FIBER REINFORCED ELASTOMERS FOR AUTO EXTERIOR PARTS

Some of the properties of thermoset urethanes can be upgraded by glass fiber reinforcement. A state-of-the-art report on materials available, how they are processed, and how their properties compare with other elastomers for exterior automobile parts is presented. The effect of glass fibers on reaction

overall properties are obtained with glass fibers in a thermoplastic urethane which, by itself, would be considered too flexible for fascia application. The glass fibers increase high temperature stiffness and enhance the low temperature impact properties.

Publ: Automotive Engineering v84 n3 p40-4 (Mar 1976)

Based on SAE-760333, "Glass Fiber Reinforced Elastomers for Automotive Applications—A Comparison of RIM Urethanes and Alternative Material Systems," by Allan B. Isham.

Availability: See publication

HS-018 450

HOW TO INVESTIGATE THE FLEET ACCIDENT

A suggested methodology for investigating fleet traffic accidents to be used by the fleet itself is presented. The tools for obtaining and preserving physical evidence regarding the accident are discussed. Suggestions for obtaining vehicle data, eyewitness accounts, environmental data, proper measurements, and statements, and reporting the results of investigation are given.

by Donald D. Lacy

Publ: Traffic Safety v76 n3 p22-4, 34-5 (Mar 1976)

Availability: See publication

HS-018 451

INFLUENCE OF NARCOTIC DRUGS ON HIGHWAY SAFETY

Available literature relevant to narcotic drug use and driver safety is reviewed. No studies were found that directly assessed driver capability either in driving simulators or actual driving conditions. There are some studies of illegal users' driving records, including interviews with methadone treated ex-heroin addicts, and laboratory studies of effects of narcotics on skills related to driving. The weight of evidence from available studies indicates that narcotic users do not have driver safety records that differ from those of age-matched individuals in the general population. Furthermore, maintenance on methadone does not provide a risk for driving.

by Norman B. Gordon

Publ: Accident Analysis and Prevention v8 n1 p3-7 (Feb 1976)

Availability: See publication

HS-018 452

AMPHETAMINES AND DRIVING BEHAVIOR

Direct evidence concerning the role of amphetamines in highway accidents is scant. Laboratory data indicate that most of the basic skills involved in driving are not adversely affected by amphetamine dosages within the normal clinical range, and may in fact be slightly enhanced. Such enhancement is generally greater in sleep-deprived subjects, but is not limited to them. Enhancement has also been noted in subjects whose skills have been degraded by alcohol, although results have not been consistent across performance measures. Although there is some evidence that amphetamines induce

overconfidence or increase risk acceptance, the effects reported have neither been so strong nor so consistent as to justify much of the apparent concern. Excessive or prolonged use is widely recognized to result in abnormal psychological states that are incompatible with safe driving performance, and known amphetamine abusers have been found to be involved in disproportionate numbers of highway accidents. Available epidemiological statistics are inadequate to establish how often such excessive consumption is associated with driving, or any other way to quantify the total contribution of amphetamine abuse to traffic accidents.

by Paul M. Hurst

Publ: Accident Analysis and Prevention v8 n1 p9-13 (Feb 1976)

Availability: See publication

HS-018 453

TRANQUILIZERS AND DRIVING

The consumption of tranquilizers has increased throughout the 1960's. At present more than 100 million prescriptions for tranquilizers are written annually in the United States. In a Norwegian study diazepam was found in the blood of 18% of people injured in traffic accidents. Other epidemiological studies have demonstrated an increased traffic accident risk to be associated with the use of tranquilizers. The combined use of tranquilizers and alcohol, which is common among patients, increases one's accident risk from that due to either agent alone. Laboratory studies concerning the effects of tranquilizers on skills related to driving have demonstrated impaired information processing capacity and eye-hand coordination due to these agents. Neuroleptics impair information processing particularly at the onset of treatment whereas the hazards of benzodiazepines become evident during long term treatment. Most of the tranquilizers increase the deleterious effects of alcohol on skills related to driving. Particularly strong is the interaction between diazepam and alcohol. At present the best countermeasure against accidents caused by tranquilizers seems to be easily available information about the effects of drugs on driving. At the onset of treatment with a neuroleptic or during long term treatment with a high dose of benzodiazepines, one should stop driving.

by Markku Linnola

Publ: Accident Analysis and Prevention v8 n1 p15-9 (Feb 1976)

Availability: See publication

HS-018 454

MARIHUANA AND DRIVING

Survey studies have found that marihuana use is increasing and that users frequently drive under its influence. But there is little direct epidemiological evidence to indicate if the presence of marihuana in drivers increases accident probability. However, there is a large body of experimental evidence indicating that marihuana impairs the performance of skills important for driving. Perception and attention functions show large decrements under marihuana with a less certain deficit for various tracking functions. Marihuana studies in driving simulators have found the greatest deficit in perceiving and responding to potential dangers from the environment. Simulator studies of risk taking have found no evidence for impairment. Several studies of performance in actual cars have also demonstrated

performance decrements but the behavioral functions impaired have not been clarified. In summary the experimental evidence suggests strongly that marihuana use while driving produces a performance impairment.

by Herbert Moskowitz
 Publ: Accident Analysis and Prevention v8 n1 p21-6 (Feb 1976)
 1976; 45refs
 Availability: See publication

HS-018 455

BARBITURATES AND DRIVING

Barbiturates are general nervous system depressants commonly used as sedatives and hypnotics. About 4% of the adult population, 12% of high school students and 19% of college students have reported using barbiturates. The lack of controlled studies comparing barbiturate involvement in traffic accidents and in the at-risk population has restricted any conclusive interpretations which can be made about the causal relationship between barbiturates and traffic accidents. Barbiturate incidence in traffic accident involvement varies from 2% to 9%. The variance in numbers represents different methods in data collection, different methods of identifying barbiturates in the body fluids, and the differences in the populations sampled. Laboratory studies have found barbiturates at moderate doses to degrade driving skills. Motor skills performance, perceptual and tracking task performance and vehicle-handling test performance are impaired under barbiturates. This impairment is further degraded by the combined use of alcohol and barbiturates beyond that found under either drug alone. It is clear that barbiturates are dangerous for driving and its effects are likely to produce impairment on those components of driving necessary for safe operation of a motor vehicle.

by Satanand Sharma
 Publ: Accident Analysis and Prevention v8 n1 p27-31 (Feb 1976)
 1976; 46refs
 Availability: See publication

HS-018 456

DRUG USE AND DRIVING RISK AMONG HIGH SCHOOL STUDENTS

An attempt was made to determine the frequency of accidents and the frequency of drug-related accidents among high school students, with comparisons of driving exposure while under various drug effects. The study population was 1538 upper level high school students in Toronto, Canada, chosen at random. Anonymous questionnaires of known validity were used to collect information about drug use, accidents, violations, drug related accidents and violations, and numbers of drug-driving occasions. Of the 1538 students, 710 had driven in the past year. About 15% reported an accident and 20% a driving offense. Users of all drugs more often reported accidents than non-users but the results were statistically significant for tobacco, marihuana, opiates, speed, lysergic acid diethylamide (LSD) and other hallucinogens. Only 2.7% had an alcohol-influenced accident and 2.0% had a drug-influenced accident. Exposure to drinking and driving was far more common than drug use and driving (56% compared to 1 to 6%). When exposure to drug related driving occasions are considered, LSD, tranquilizers, and stimulants are the most dangerous drugs, more dangerous than alcohol. The infrequent use of drugs

makes their total effect on accidents small compared to alcohol.

by Reginald G. Smart; Dianne Fejer
 Publ: Accident Analysis and Prevention v8 n1 p33-8 (Feb 1976)
 1976; 13refs
 Availability: See publication

HS-800 721

SUGGESTED MODIFICATIONS IN STATE LICENSING MANUALS TO ENCOURAGE SAFETY BELT USAGE

The importance of using state driver licensing manuals to promote safety belt usage is discussed. To the greatest extent possible, safety belt information should be included in each state's driver handbook to emphasize the importance of this subject; test items should be included as samples in the handbook and, if possible, as items in the licensing examination. Some prototype materials are presented: expository text, question-and-answer sequences, slogans, illustrations, fillers, and test items.

by Martha W. Goodison; Paul A. Alter; Harris H. Shettel
 American Institutes for Res., 710 Chatham Center Office Bldg., Chatham Center, Pittsburgh, Pa. 15219
 Contract FH-11-7522
 1972; 28p
 Availability: GPO, stock no. 5003-0072

HS-801 200

TECHNICAL REPORTS OF THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION. A BIBLIOGRAPHY 1967-1973

National Highway Traffic Safety Administration (NHTSA) technical reports for the period 1967-1973 are cited. They are the products of research and testing that fulfill the objectives of NHTSA in the fields of highway and motor vehicle safety. Entries are arranged by accession number (HS number), and are indexed by corporate author, personal author, contract and project number, report number, and keyword-in-context (KWIC).

by Clara F. Hardee, comp.
 National Hwy. Traffic Safety Administration, Office of Management Systems, Washington, D.C. 20590
 1974; 420p
 Annual update for Dec 1967-Dec 1973. Supersedes HS-820 252.
 Availability: NTIS

HS-801 212

AUDIOVISUAL CATALOG OF THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, DECEMBER 1970-DECEMBER 1973

A listing of the motion-picture films, slides, tapes, and still photographs available from the Technical Services Division of the Office of Management Systems of the National Highway Traffic Safety Administration is presented. The catalog section of this listing of audiovisuals is arranged by sequential number reflecting the storage arrangement and provides the following information on each item: footage, contractor or organization responsible for making the audiovisual, title, date of produc-

tion, number of copies, and any restrictions on the availability of the item. Short descriptions of the material covered in the audiovisual are also presented. A KWIC, or keyword in context index, displays each significant work in the title entry in alphabetical order for each audiovisual.

by Clara F. Hardee, comp.
National Hwy. Traffic Safety Administration, Office of Management Systems, Washington, D.C. 20590
1974 ; 850p
Annual update for Dec 1970-Dec 1973. Supersedes Audiovisual Catalog of the National Hwy. Traffic Safety Administration, Dec. 1970-Dec 1972.
Availability: NTIS

HS-801 215

CERTIFICATION INFORMATION REQUESTS OF THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

The Certification Information Request (CIR) files of the National Highway Traffic Safety Administration (NHTSA) which are cited in this catalog are the results of inquiries made by the Office of Standards Enforcement (OSE) to those vehicle and equipment manufacturers covered by the requirements of the National Traffic and Motor Vehicle Safety Act of 1966. The file consists of: investigations resulting from vehicle or equipment testing to determine compliance with Federal Motor Vehicle Safety Standards (a CIR is initiated whenever a test conducted by OSE results in a failure to pass standard test procedures); investigations of vehicle or equipment manufacturers resulting from information obtained from industry disclosures, periodicals, newspaper articles, and letters from the general public; investigations of vehicles for compliance to Certification Regulation, Part 567; and investigations of distributors and dealers for compliance to the Tire Identification and Recordkeeping Regulation, Part 574. Citations in the catalog include the following elements: a sequential IR number assigned for inventory control; the CIR number assigned by OSE; the company name and item tested; the standard number; and the date. A KWIC Index displays each significant work in the CIR entry, providing a quick abstract or further identification of the particular CIR sought by the user.

by Virginia Padgett, comp.; Clara F. Hardee, comp.
National Hwy. Traffic Safety Administration, Office of Management Systems, Washington, D.C. 20590
1974 ; 320p
Availability: NTIS

HS-801 304

MULTIDISCIPLINARY ACCIDENT INVESTIGATION SUMMARIES. VOL. 5, NO. 6

Case reports of in-depth accident investigations are summarized. These investigations are being conducted to identify contributing factors and injury causation, to evaluate the effectiveness of countermeasures, and to detect design and functional problems of the vehicle and highway. The reports are individual, clinical studies of accidents, generally involving vehicles in the last three model years, of fatal, injury producing, or property damage severity. Each summary consists of identification information including time, date, and location of the accident; a description of the highway, vehicles, drivers, and occupants involved; a narrative of the sequence of events

of the collision including details of the precrash, crash, and postcrash phases; an assessment of injuries and damage; and a list of applicable standards, causal factors, conclusions, and recommendations. A diagram of each collision is included. Summaries of 50 case reports are given.

National Hwy. Traffic Safety Administration, Office of Accident Investigation and Data Analysis, Washington, D.C. 20590
1974 ; 264p
Availability: NTIS

HS-801 305

MULTIDISCIPLINARY ACCIDENT INVESTIGATION SUMMARIES. VOL. 5, NO. 7

Case reports of in-depth accident investigations are summarized. These investigations are being conducted to identify contributing factors and injury causation, to evaluate the effectiveness of countermeasures, and to detect design and functional problems of the vehicle and highway. The reports are individual, clinical studies of accidents, generally involving vehicles in the last three model years, of fatal, injury producing, or property damage severity. Each summary consists of identification information including time, date, and location of the accident; a description of the highway, vehicles, drivers, and occupants involved; a narrative of the sequence of events of the collision including details of the precrash, crash, and postcrash phases; an assessment of injuries and damage; and a list of applicable standards, causal factors, conclusions, and recommendations. A diagram of each collision is included. Summaries of 50 case reports are given.

National Hwy. Traffic Safety Administration, Office of Accident Investigation and Data Analysis, Washington, D.C. 20590
1974 ; 341p
Availability: NTIS

HS-801 643

RECOMMENDATIONS FOR RESEARCH ON UNSAFE TARGET DRIVING BEHAVIORS AND SAFE DRIVING CONFORMANCE COUNTERMEASURE APPROACHES. FINAL REPORT

Research requirements for the development of a safe driving conformance program were investigated. Seven significant areas of initiatives to impact target driving behavior were investigated. A research program is recommended which consists of seven separate research modules, each of which represents an area in which there is a significant lack of information at present. The proposed research modules are addressed to the following areas: target driving behaviors; citizen participation; detection; drivers and risk taking; traffic law system; social conformance measures; and experimental studies. The purpose of the first research module is to identify the target driving behaviors against which countermeasure programs can be directed in a safe driving conformance program. The purpose of the second module is to identify and evaluate the ways in which citizen groups can assist police and government officials in the detection of unsafe driving behaviors and in implementation of countermeasure programs. A variety of detection techniques should be defined and investigated through experiments using each technique. A conceptual framework by which appropriate detection techniques could be

ing activities in general, and drivers' perception of the degree of risk and their tolerance for acceptable levels of risk associated with specific target driving behaviors should be investigated. More effective traffic law countermeasures should be developed for testing in experimental programs to reduce the occurrence of target driving behaviors. Research tasks involved in the sixth module include identifying countermeasure initiatives, relating countermeasures to target driving behaviors, estimating the efficacy of countermeasures, and recommending countermeasures for experimental testing. A series of field experiments should then be devised to determine the ability of a countermeasure or a set of countermeasures to reduce or eliminate the occurrence of target driving behavior.

by Jay W. Worrall; Robert L. Hiett
Human Sciences Res., Inc., Westgate Res. Park, 7710 Old
Springhouse Rd., McLean, Va. 22101
Contract DOT-HS-4-00988
Rept. No. HSR-RR-75/4-We ; 1975 ; 30p 16refs
Report for 28 Jun 1974-30 Apr 1975.
Availability: Corporate author

HS-801 668

MULTIDISCIPLINARY ACCIDENT INVESTIGATION SUMMARIES. VOL. 6, NO. 11

Case reports of in-depth accident investigations are summarized. These investigations are being conducted to identify contributing factors and injury causation, to evaluate the effectiveness of countermeasures, and to detect design and functional problems of the vehicle and highway. The reports are individual, clinical studies of accidents, generally involving vehicles in the last three model years, of fatal, injury producing, or property damage severity. Each summary consists of identification information including time, date, and location of the accident, a description of the highway, vehicles, drivers, and occupants involved, a narrative of the sequence of events of the collision including details of the precrash, crash, and postcrash phases, an assessment of injuries and damage, and a list of applicable standards, causal factors, conclusions, and recommendations. A diagram of each collision is included. Summaries of 50 case reports are given.

National Hwy. Traffic Safety Administration, Office of
Accident Investigation and Data Analysis, Washington, D.C.
20590
1975 ; 321p
Availability: NTIS

HS-801 669

MULTIDISCIPLINARY ACCIDENT INVESTIGATION SUMMARIES. VOL. 6, NO. 12

Case reports of in-depth accident investigations are summarized. These investigations are being conducted to identify contributing factors and injury causation, to evaluate the effectiveness of countermeasures, and to detect design and functional problems of the vehicle and highway. The reports are individual, clinical studies of accidents, generally involving vehicles in the last three model years, of fatal, injury producing, or property damage severity. Each summary consists of identification information including time, date, and location of

the collision including details of the precrash, crash, and postcrash phases, an assessment of injuries and damage, and a list of applicable standards, causal factors, conclusions, and recommendations. A diagram of each collision is included. Summaries of 50 case reports are given.

National Hwy. Traffic Safety Administration, Office of
Accident Investigation and Data Analysis, Washington, D.C.
20590
1975 ; 352p
Availability: NTIS

HS-801 729

ALCOHOL SAFETY ACTION PROJECTS. EVALUATION OF OPERATIONS-1974. VOL. 2. DETAILED ANALYSIS. CHAP. 5, EVALUATION OF THE REHABILITATION COUNTERMEASURE ACTIVITIES

The Alcohol Safety Action Project (ASAP) rehabilitation subsystem, designed to modify the behavior of persons convicted of driving while intoxicated (DWI) in a manner that would reduce the probability of subsequent DWI behavior, is evaluated. A conceptual model of the ASAP court referral system is provided along with tables and graphs depicting ASAP processing by drinker type, by treatment modality type (alcohol safety school, group therapy, chemotherapy, individual therapy, in-patient treatment, and Alcoholics Anonymous), and within the alcohol safety school modality alone. Entry and termination rates are given. Analyses of the alcohol safety schools at the project and the program levels are discussed. It was found that: there is evidence that the schools caused increase in knowledge and positive attitude changes; lecture-oriented schools may have a negative effect on extreme problem drinkers; group therapies appeared to result in positive changes in terms of intermediate measures; rehabilitation across modalities in terms of intermediate measures might give some positive effect, but no firm evidence indicated that rehabilitation was effective across modalities in terms of rearrest and crash involvement; drinking-related variables are more relevant to rehabilitation completion and subsequent recidivism than are demographic variables; and more emphasis needs to be placed on life change data in the evaluation of some of the group therapy and educational programs currently being utilized at various ASAP sites. Future rehabilitation efforts and reports are described: analytic studies, a short term rehabilitation study, and a comprehensive DWI treatment demonstration.

National Hwy. Traffic Safety Administration, Office of Driver
and Pedestrian Programs, Washington, D.C. 20590
1974? ; 34p 4refs
Availability: Corporate author

HS-801 833

A STATISTICAL ANALYSIS OF SEAT BELT EFFECTIVENESS IN 1973-75 MODEL CARS INVOLVED IN TOWAWAY CRASHES. INTERIM REPORT

Using a probability sample of towaway accidents involving 1973 through 1975 model cars and investigations by special teams in five different geographic regions, several multivariate

analyses were examined which estimate injury rates and corresponding effectiveness relating to various levels of safety belt usage. The effective sample size is 10,758 occupants--drivers or right front seat passengers--for whom belt usage and Abbreviated Injury Scale (AIS) injury information, as well as age and seat position, car weight, crash configuration, and vehicle damage severity data, is available. Of this sample, 56.3% of the occupants were unrestrained, 16.9% wore a lap belt only, and 26.8% wore both lap and shoulder belts. Lap and shoulder belt usage was shown to jump considerably with the 1974 model cars. If injured is defined as an AIS equal to or greater than 2, then 9.7% of the sample was injured. Data indicate that 12.3% of the unrestrained occupants, 8.5% of the persons using lap belts, and 5.0% of the persons using lap and shoulder belts sustained injuries. A log-linear model combined with weighted values for crash configuration, vehicle damage severity, vehicle weight, and occupant age/seat position was used as the primary analysis procedure to control for the variables interacting with belt usage in determining injury rates. The primary effect of controlling for these variables was to increase the crude injury rate for lap belted occupants from 8.5% to 9.3%, while the rate for unrestrained occupants decreased from 12.3% to 12.0% and that for lap and shoulder belted occupants increased from 5.0% to 5.1%. A detailed sensitivity analysis was conducted to determine the effect of controlling for these variables on the effectiveness estimates and the overall injury rates. Generally, it appears that controlling for vehicle damage is the most important, with crash configuration next in importance. Controlling for age and seating position was shown to have the least effect on the crude effectiveness estimates. Considerable data from these studies are included.

by Donald W. Reinfort; Claudio Z. Silva; Yosef Hochberg
University of North Carolina, Hwy. Safety Res. Center,
Chapel Hill, N.C. 27514
Contract DOT-HS-5-01255
1976 ; 108p 8refs
Report for 1 Jul-31 Oct 1975.
Availability: NTIS

HS-801 834

IMPLEMENTATION OF POWER MOTIVATION TRAINING AS A REHABILITATION COUNTERMEASURE FOR DWIS. FINAL REPORT

The use of Power Motivation Training (PMT), a group of countermeasures to alcohol abuse, as a part of the rehabilitation aspect of the Alcohol Safety Action Project (ASAP) is discussed. PMT seeks to make the problem drinker aware of his need to feel powerful as the cause of problem drinking. The application of PMT to ASAP is considered, in terms of counselor training and organizational change. A competency model for counselors, a schedule of counselor training, and an evaluation questionnaire of the training are included. Literature relating to the PMT project such as candidate questionnaires, a description of the project and applications of it, and relevant letters are appended.

by Richard E. Boyatzis
McBer and Co., 137 Newbury St., Boston, Mass. 02116
Contract DOT-HS-350-3-707
Rept. No. 317F ; 1976 ; 106p refs
Report for 22 Jun 1973-31 Dec 1975.
Availability: NTIS

HS-801 835

TRAINING PROGRAM FOR EMERGENCY MEDICAL TECHNICIAN DISPATCHER: FINAL REPORT

A package of instruction for the emergency medical dispatcher was prepared by following a systematic instructional systems development approach. The functions of the dispatcher in the emergency medical system environment were analyzed. A complete specification of job performance requirements were derived and reviewed. The required skills and knowledges were identified and criteria and enabling objectives specified. These were sequenced into eleven instructional units and the detailed content was prepared. The final course contains a Course Guide, Instructional Lesson Plans, and a Student Study Guide. An example page from the instructor lesson plans and from the student study guide are included. The final program, the Emergency Medical Technician (EMT) Dispatcher Instructional Program, has the following specifications: it is an instructor-led, group lock-step program in two parts, the first covering basic dispatching functions and the second part covering those additional dispatching functions which are the responsibility of a trained EMT; the first part will require 7-16 hours to administer, the second 8-17; and the program is dependent on the availability of a trained and dedicated instructor who will have to customize the materials to insure they satisfy local dispatching requirements and cover local conditions.

by Sanford P. Schumacher; Andrew P. Chenzoff
INNOVATRIX, Inc., Box 371, Ingomar, Pa. 15127
Contract DOT-HS-5-01271
1976 ; 38p 27refs
Report for 30 Jun-31 Dec 1975.
Availability: NTIS

HS-801 836

MOTORCYCLE SAFETY. THE CASE FOR HELMET USE

Research conducted over the past 30 years is reviewed in order to demonstrate that motorcycle helmets are an effective safety device. In response to research conducted in Great Britain and Australia and to motorcycle accident statistics, the National Highway Traffic Safety Administration included a motorcycle safety standard as one of 13 initial Highway Safety Programs Standards issued in June, 1967. Under this standard, states are required to provide that each motorcycle operator and passenger wear an approved safety helmet. It is suggested that available data from research and state experience show that: helmet use has helped to reduce the yearly motorcycle fatality rate, in terms of deaths per 10,000 registrations; motorcycle helmets reduce the incidence of head injuries when worn; helmets do not place undesirable restrictions on the rider nor increase the chances for neck injuries; and mandatory helmet use laws reduce the number of serious injuries and fatalities resulting from motorcycle accidents. It is concluded that motorcycle helmet use greatly decreases the likelihood of a fatal and serious injury if an accident does occur, and that the helmet is an effective and necessary piece of safety equipment for motorcycle operators and passengers. Figures are tabulated for: motorcycle registration and fatalities; head injury rates by helmet use in Sacramento County, Calif.; head injury rates for motorcycle riders in Michigan and Illinois; and

helmet use and head injury before and after mandatory helmet use legislation.

by Penelope Johnson; Lewis Buchanan; Paul Levy
National Hwy. Traffic Safety Administration, Office of Driver
and Pedestrian Programs
1976; 13p 16refs
Availability: Corporate author

HS-801 837

EXTENSIONS AND REFINEMENTS OF THE CRASH COMPUTER PROGRAM. PART 1. ANALYTICAL RECONSTRUCTION OF HIGHWAY ACCIDENTS. FINAL REPORT

A number of significant improvements incorporated in the Calspan Reconstruction of Accident Speeds on the Highway computer program without any measurable penalty in operating costs are discussed. The program was modified to: improve its accuracy and user convenience in the prediction of trajectories involving spins; permit the optional entry of two, four and six measurements of damage extent in the calculation of absorbed energy; improve the interpretation of damage in oblique collisions; and adapt the program as a preprocessor for the Simulation Model of Automobile Collisions computer program.

by Raymond R. McHenry
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-5-01124
Rept. No. ZQ-5708-V-2; 1976; 30p 3refs
Report for 3 Apr-15 Nov 1975.
Availability: NTIS

HS-801 838

EXTENSIONS AND REFINEMENTS OF THE CRASH COMPUTER PROGRAM. PART 2. USER'S MANUAL FOR THE CRASH COMPUTER. FINAL REPORT

The Calspan Reconstruction of Accident Speeds on the Highway (CRASH) computer program is an accident investigation aid designed to achieve uniformity in the interpretation of physical evidence from automobile accidents. The CRASH program is designed to accommodate a range of accident evidence, from vehicle damage indices only at one extreme to complete definitions of rest and impact positions as well as damage dimensions at the other. Multiple outputs of speed change and/or impact speed can be provided with identification of the basis for each approximation. The user can thus select the approximation result based on the most reliable items of evidence, while assuring that the different items of evidence are at least grossly compatible. The computer costs for time-sharing operation of the CRASH program in its present form range from about one to five dollars per case, depending on the extent of the input information. The structural development of the computer program, in terms of solution procedures, program logic, and input and output formats, is considered to be complete, although stored tables of vehicle parameter data and of empirical coefficients that are applied in the programmed calculations must be recognized as first approximations that can subsequently be refined. Initial trial applications to stage collisions have indicated an overall accuracy range of about 12%, but this figure is not considered to be representative of the potential accuracy of the reconstruction technique. The specific questions which must be answered by the CRASH program user are presented and discussed. A sam-

ple output format is included. The calculation procedures for spinout analysis and damage analysis are presented and explained.

by Raymond R. McHenry
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-5-01124
Rept. No. ZQ-5708-V-3; 1976; 67p 8refs
Report for 3 Apr-15 Nov 1975.
Availability: NTIS

HS-801 840

AN ANALYSIS OF MOTORCYCLE SIDE IMPACT

An experimental investigation was conducted into the severity of injuries experienced by motorcycle riders when their machine is hit from the side by an automobile. A series of six impact tests was conducted using an instrumented dummy to obtain acceleration readings of head and chest and bending forces on upper and lower leg bones. Three of the tests were conducted with a Harley-Davidson production street motorcycle and three with a highly modified version of the same motorcycle. All tests were conducted with a 50th percentile male anthropomorphic dummy instrumented in the head, chest, upper leg, and lower leg. The motorcycle and dummy were impacted at a speed of about 30 mph with a full-size standard American production sedan. Test results were recorded on magnetic tape, high-speed motion pictures, and still photographs. The following conclusions were drawn from the test results: forces measured on the lower extremities of riders indicate that the injury hazard to the rider decreases appreciably as the direction of impact becomes more oblique; the side structure on the modified unit reduced the magnitude of forces measured on both the upper and lower legs of the rider, but generally resulted in higher chest and head accelerations, indicating that by removing the load transfer path of the motorcycle through the leg, the car represents a greater overall hazard to the life of the rider; it appears that 30 mph impacts produced chest accelerations well below the fatality thresholds for motorcycle riders; peak resultant head accelerations recorded for 30 mph impacts were above the fatality thresholds; rear oblique impacts result in significantly higher accelerations to the chest and head than do the front oblique impacts; and the most severe blow to the motorcycle rider occurs at the point of impact between the side of the head and the hood of the automobile. It is suggested that a simple bumper protection guard placed in front of the rider's legs and a low silhouette bucket-type seat which engages the rider at the pelvis and is attached to the motorcycle structure through energy absorbers could provide significant protection to the rider during side impacts without unduly restricting the driver or preventing voluntary separation from the machine in other types of accidents or situations. Pre-, mid-, and post-impact photographs, diagrams, and data graphs and tables are provided.

by G. D. Livers
AMF Advanced Systems Lab., 495 South Fairview Ave.,
Goleta, Calif. 93017
Contract DOT-HS-4-00815
1976; 96p 15refs
Interim rept. of test results for Oct 1973-Sep 1974.
Availability: NTIS

HS-801 841

**STATE DRIVER IMPROVEMENT ANALYSIS
REPORT ON PROGRAM
STATUS/RECOMMENDATIONS. VOL. 1. SUMMARY.
FINAL REPORT**

by John P. McGuire
Public Systems Inc., 1137 Kern Ave., Sunnyvale, Calif. 94086
Contract DOT-HS-4-00967
Rept. No. TP-205-Vol-1 ; 1976 ; 81p 44refs
Report for Jul 1974-Nov 1975. For abstract, see HS-801 842.
Availability: NTIS

HS-801 842

**STATE DRIVER IMPROVEMENT ANALYSIS
REPORT ON PROGRAM
STATUS/RECOMMENDATIONS. VOL. 2.
TECHNICAL REPORT. FINAL REPORT**

A comprehensive review of the literature pertaining to driver improvement effectiveness and a detailed examination of prior state-of-the-art reviews are presented. Discussion is presented regarding evidence that: traffic violation frequency can be reduced by a variety of techniques, including warning letters, group meetings and individual hearings; paradoxically, conviction reduction has not generally been accompanied by accident reduction even though accidents and convictions are known to be correlated; reduction in accident frequency has proven very difficult to demonstrate; the results of most studies must be regarded as negative or equivocal and, where significant reductions have been reported, the treatment effects have usually been small or transitory or the studies have not been sufficiently rigorous; and there has been failure to conduct evaluative research on a programmatic basis and attempts at replicating prior research have been rare. The highlights of the results of an on-site survey of the driver licensing agency driver improvement program of each state are presented. In addition, key information gleaned from the responses to a mailed questionnaire survey to selected court referral driver improvement programs is described. The desirable attributes of a driver improvement program are presented in terms of a model driver improvement system. The model system includes descriptions of a planning component, an operations component, and a research and evaluation component. A strategy for National Highway Traffic Safety Administration funding for selected, recommended driver improvement program implementations in the states is described. Based on the model and the results of the surveys, specific recommendations for each state are presented along with a schedule for implementation in the one, two to three, and three to ten year time frames.

by John P. McGuire
Public Systems Inc., 1137 Kern Ave., Sunnyvale, Calif. 94086
Contract DOT-HS-4-00967
Rept. No. TP-205-Vol-2 ; 1976 ; 264p 82refs
Report for Jul 1974-Nov 1975.
Availability: NTIS

HS-801 843

**STATE DRIVER IMPROVEMENT ANALYSIS
REPORT ON PROGRAM/STATUS**

**RECOMMENDATIONS. VOL. 3. APPENDICES. FINAL
REPORT**

Data on the status of driver improvement nationally and in the various states is presented. Tabulations of the responses of state licensing agency driver improvement officials to a survey questionnaire regarding driver improvement programs are presented. Some data are presented only on the basis of total responses, while other data are presented by state. A narrative summary of the driver improvement programs currently operating in each state is also included. The summaries are based on the questionnaire responses, on-site interviews, and data collected in each state. In each summary, the state program is described in terms of: basic statistics; agency organization; records system; point system; current programs; license renewal procedures; court referral programs; research; and constraints. The list of respondents to a questionnaire on court referral driver improvement programs is presented. In addition, those programs identified for receipt of a questionnaire and those programs identified but not furnished with a questionnaire are listed in order to provide an expanded but incomplete reference list of court referral programs.

by John P. McGuire
Public Systems Inc., 1137 Kern Ave., Sunnyvale, Calif. 94086
Contract DOT-HS-4-00967
Rept. No. TP-205-Vol-3 ; 1976 ; 377p
Report for Jul 1974-Nov 1975. Vols. 1-2 are HS-801 841 and 801 842.
Availability: NTIS

HS-801 844

**DEVELOPMENT OF VEHICLE RATING SYSTEMS
FOR THE AUTOMOBILE CONSUMER
INFORMATION STUDY. VOL. 1. SUMMARY. FINAL
REPORT**

General Electric Co., Information Systems Programs, 1755
Jefferson Davis Hwy., Arlington, Va. 22202
Contract DOT-HS-4-00903
Rept. No. GE-957-346-200 ; 1976 ; 25p 12refs
Report for Jun 1974-Jan 1976. For abstract, see vol. 2, HS-801 845.
Availability: NTIS

HS-801 845

**DEVELOPMENT OF VEHICLE RATING SYSTEMS
FOR THE AUTOMOBILE CONSUMER
INFORMATION STUDY. VOL. 2. TECHNICAL.
FINAL REPORT**

A study was conducted to develop a methodology capable of rating motor vehicles according to their damage susceptibility, crash-worthiness, and maintainability characteristics. The major sources of data used in the preliminary development of damage susceptibility and crash-worthiness methodologies were insurance claims, state accident records, and special files retained by the National Highway Traffic Safety Administration (NHTSA). Motor vehicle fleet operations proved to be the most reliable source for maintainability information. A systems engineering approach was used to develop a Vehicle Rating Data System for the processing of applicable data, data storage, and summary accumulation of information required for rating cars with regard to damage susceptibility, crash-worthiness, and maintainability. A predictive system was

developed which provides procedures for identifying significant design changes in new model year cars and methodologies for evaluating the effects of these design changes on the damage susceptibility, crashworthiness, and maintainability characteristics of the various makes and models. Vehicle components which significantly influence the damage susceptibility and crashworthiness characteristics of a vehicle were identified. Existing mathematical models were then used to evaluate the effects of design changes of these critical components on damage and occupant injury. Measurements from crash tests were used to evaluate the simulation performance of the models. Methodologies for projecting the damage susceptibility and crashworthiness performance of the new model year cars were based on the simulated effects of the design changes and a system for rating new model year cars based on their projected performance in the field was developed. Methods were then investigated for projecting the maintenance requirements for those components whose physical design or operational environment would be altered by a design change. However, the feasibility of these methods was determined during the study period. A study of the effects of the Vehicle Rating Data System might have on insurance premiums resulted in the conclusion that most of the factors associated with determining the cost of an automobile insurance policy were not directly related to the vehicle. It was included that the insurance industry does not now utilize the damage susceptibility and crashworthiness characteristics of a specific vehicle in determining rate structures.

General Electric Co., Information Systems Programs, 1755 Jefferson Davis Hwy., Arlington, Va. 22202
Contract DOT-HS-4-00903; Ref: DOT-HS-4-00909; Ref: DOT-HS-4-00910; Ref: DOT-HS-4-00904
pt. No. 957-346-200; 1976; 157p 98refs
Report for Jun 1974-Jan 1976. Summary is HS-801 844.
Availability: NTIS

HS-801 846

FINITE ELEMENT ANALYSIS OF AUTOMOTIVE STRUCTURES UNDER CRASH LOADINGS. VOL. 1. SUMMARY. FINAL REPORT

R. E. Welch; R. W. Bruce; T. Belytschko
Res. Inst., 10 West 35 St., Chicago, Ill. 60616
Contract DOT-HS-105-3-697
pt. No. IITRI-J6321-Vol-1; 1976; 25p
Report for 30 Jun 1973-30 Jun 1975. For abstract, see Vol. 2, HS-801 847.
Availability: NTIS

HS-801 847

FINITE ELEMENT ANALYSIS OF AUTOMOTIVE STRUCTURES UNDER CRASH LOADINGS. VOL. 2. TECHNICAL REPORT. FINAL REPORT

Research program project designed to develop a finite element computer program for use in the dynamic analysis of vehicle structures, including sheet metal, in a crash environment, is described. The response of vehicle structures under crash loadings is a complex process primarily involving: transient, dynamic behavior; complicated framework and shell elements; large deflections and rotations; and extensive plastic deformation. A technique was developed for the finite element analysis of the dynamic response of plate beam structures involving very large displacements and rotations and

elastic-plastic material behavior. The principal feature of this technique involves the decomposition of the element displacement field into rigid body components and deformation components, thus allowing the use of a small deflection element formulation in the analysis. A computer program was developed incorporating this analysis procedure for beam and plate elements and rigid links together with appropriate time integration procedures and material property descriptions. A substantial number of test and demonstration problems were analyzed with this computer program ranging from simple classical solutions for beams and plates through large scale simulations of actual crash tests. It is concluded that the analysis formulation is a formally sound procedure and a proper and useful approximation technique for the dynamic analysis of beam and plate structures involving large deflections and rotations. The computer program developed was found to be a correct rendering of the analysis technique and to provide accurate results with reasonable efficiency in comparison to available known solutions. The computer program is readily applicable to realistic vehicle structures and provides credible results for actual crash events, as demonstrated by simulations of the end-on barrier tests. Computer program input data and program listings are included.

by R. E. Welch; R. W. Bruce; T. Belytschko
Res. Inst., 10 West 35 St., Chicago, Ill. 60616
Contract DOT-HS-105-3-697
Rept. No. IITRI-J6321-Vol-2; 1976; 161p 33refs
Report for 30 Jun 1973-30 Jun 1975. Summary is HS-801 846.
Availability: NTIS

HS-801 852

ACCIDENT AVOIDANCE SKILL TRAINING AND PERFORMANCE TESTING: FINAL REPORT

A two-phased study was conducted to determine the feasibility of training drivers to acquire the skills needed to avoid critical conflict motor vehicle accidents and to develop the procedures and materials necessary for such training. The first phase utilized a three-member team to determine the accident and pre-accident characteristics, identify the driver behavior requirements, and assess the feasibility of a program to train drivers in accident avoidance techniques. In-depth analyses of accident situations were undertaken to determine if the accidents in question were identifiable, classifiable, and avoidable. Task and behavioral analyses of a set of potential accident situations were also conducted to identify the knowledge, skill, behavior, and maneuvering requirements for successfully avoiding an accident or collision. It was concluded that it is potentially feasible to train drivers to avoid automobile multivehicle collisions. The second phase involved the development and testing of training materials and the preparation of a plan for evaluating them in an operational setting. A "bimodal" driving simulator capable of providing visual feedback to the operator of the dynamics of a multivehicle conflict situation was developed in a prototype configuration. A method was defined which will permit simulation of multivehicle conflicts on a driving range without the risks inherent in potential two-car crashes. Research is still required to develop means of evaluating the Accident Avoidance Skill Training program, to develop training materials and programs to meet the special needs of particular classes of drivers, such as bus drivers, and

to investigate increased scope for the program. Curriculum and performance measurement specifications are appended.

by G. Richard Hatterick; James R. Bathurst
URS/Matrix Co., 7245 Arlington Blvd., Falls Church, Va.
22042

Contract DOT-HS-4-00960

Rept. No. PR-0530-28; PB-252 027 ; 1976 ; 394p refs

Report for Jul 1974-Jan 1976.

Availability: NTIS

HS-801 854

EFFECT OF THE FUEL CRISIS AND THE 55 MPH LIMIT ON FATALITIES IN UTAH

A time series analysis procedure was used to determine the effects of the fuel crisis and the 55 mph maximum speed limit law on fatalities in the state of Utah. Monthly fatalities resulting from traffic accidents during the period January 1971 through August 1975 were examined. The baseline period used for the study includes January 1971 through October 1973. A mathematical model was developed for the baseline period for use in forecasting the expected fatalities during the period October 1973 through December 1975. These predicted values were then compared with the actual fatality figures to determine if conditions producing highway fatalities in the post energy crisis period and the 55 mph speed limit period were the same as in the baseline period. A multivariate modelling approach was used to relate the effect of the fuel crisis and of the 55 mph speed limit individually on crash levels. The results of this analysis indicate that the fuel crisis alone would have resulted in a reduction of 9.8 fatalities per month if it had remained in effect. A reduction of 9.6 fatalities per month is attributed to the presence of the 55 mph maximum speed limit. These savings estimates were both found to be statistically significant. In the case of the fuel crisis, there was a one month delay in the effects on fatalities, while the 55 mph speed limit had an immediate effect. When the multivariate model was used to predict the actual numbers of fatalities experienced in Utah after October 1973, it was found to provide an adequate description of what actually happened, with all actual values lying within the 90% confidence bands. It is concluded that in Utah the fuel crisis resulted in a reduction of about 9.8 fatalities per month and that the 55 mph speed limit resulted in a reduction of about 9.6 fatalities per month.

by Terry M. Klein; Paul Levy; Robert B. Voas
National Hwy. Traffic Safety Administration, Demonstration
Evaluation Div.
1976 ; 19p refs
Availability: NHTSA

HS-801 855

THE RELATIONSHIP BETWEEN SAFETY BELT USAGE AND THEIR CONFIGURATION. FINAL REPORT

In the fall of 1971, safety belt usage was observed for more than 9,000 front seat occupants of certain late model automobiles in California operating in both low speed and high speed driving situations. Data were obtained for Chrysler, Ford, and General Motors passenger cars for model years 1968 through 1971. Chrysler Corporation automobiles used 4-point anchorage belts with buckles of the lift latch type, with push button buckle releases being used in the latter half of the 1971

model year. Most Chrysler cars used manual adjustment for the belts. The Ford Motor Company used the push button release for all lap belts during the model years 1968 through 1971. Manually adjusted belts were used in 1968 and 1969 Ford cars and automatic fixed adjustment was used for belts installed in 1970 and 1971 models. General Motors Corporation vehicles were equipped with lap and shoulder belts with virtually identical design features during the model years 1968 through 1971. The front seat lap belt and shoulder belts are separate (4-point anchorage) and buckles on the lap belt and the shoulder belt are released by a push button mechanism. Both manual and automatic adjustment buckles were used. Observations were conducted while vehicles were stopped at a traffic signal or stop sign, where seat belt usage and license numbers were recorded. The observations were conducted prior to, during, and following a radio and television campaign promoting the use of safety belts. The pattern of safety belt usage was found to be similar to that observed in previous studies: usage was greater in high speed driving situations than in low speed situations; lap belt usage was in the range of 10% to 20%; and shoulder belt usage was quite low, generally about 3% or less. Belt usage did not appear to be a function of vehicle age. There was very little evidence that belt usage is a function of configuration within the vehicle. Only two of fourteen relevant tests supported the hypothesis that usage is a function of belt configuration. In addition, belt usage does not appear to be a function of vehicle manufacturer.

by Gerald A. Fleischer
University of Southern California, Industrial and Systems
Engineering, Los Angeles, Calif. 90007
Contract NHTSA-2-2980
Rept. No. ISE-TR-72-4 ; 1972 ; 27p 8refs
Report for Mar-Jun 1972.
Availability: Reference copy only

HS-801 856

IN-VEHICLE SYSTEMS TO WARN OF APPROACHING TRAINS AND EMERGENCY VEHICLES. CONCEPT PAPER

A systematic approach to the formulation of the problem of vehicle collisions with trains at railroad grade crossings and with emergency vehicles is presented, and potential approaches to solving the problem are proposed. A review of the types of hardware devices that have been proposed to deal with certain aspects of the problem of in-vehicle warning systems for trains and emergency vehicles is also presented. The problem may be viewed either as part of the total problem of vehicular communications, involving reaction to various types of information from all other vehicles, or as a separate problem related only to the causal events of emergency vehicle or railroad crossing accidents. The only intervehicular or vehicle-environment communications devices currently in general use are vehicle lighting systems, horns, and road signs. The two basic approaches which have been taken towards a hardware solution to the problem of trains and emergency vehicle accidents are: the use of a microphone pickup outside the vehicle to sense the sound from the horns of trains, emergency vehicles, and other auto horns; and the use of radio frequency transmission, which requires a receiver in every vehicle and a transmitter in every train engine and emergency vehicle. Both of these approaches have significant drawbacks which limit their usefulness. Other alternatives to solution of the problems which should be investigated further include: reduction of emergency runs; special training for operators of

emergency vehicles; better training for school bus drivers; and improvement of safety at railroad grade crossings through such measures as better passive warning signs, special color schemes to improve the visibility of trains, and improved sight distances. The following recommendations are made for further research activity: evaluation of accident data for emergency vehicles to determine the causal factors and determine possible countermeasures; investigation of the need for emergency runs and development of guidelines for the training of drivers of emergency vehicles; testing and evaluation of some of the countermeasures proposed to alleviate problems at railroad crossings; cost-benefit analysis of train and emergency vehicle in-vehicle warning systems and comparison with the cost-benefit analyses of other countermeasures; and a review of the literature to determine the effect of false alarms.

National Hwy. Traffic Safety Administration, Office of Driver Performance Res.
1972 ; 32p Srefs

Availability: Reference copy only

HS-801 857

RESEARCH SAFETY VEHICLE (RSV) PHASE 2. STATUS REPORT NO. 4, 16 JANUARY TO 15 MARCH 1976

Work conducted on the development of a Research Safety Vehicle (RSV) by the Calspan Corporation during the period 16 January through 15 March 1976 is reported. Developmental engineering efforts during this period were focussed on the design of the structures, bumpers, and restraint systems. A car-to-car compatibility study was conducted using the Calspan vehicle collision model to simulate front-to-front, front-to-side, and front-to-rear collision situations. A pedestrian/bumper impact simulation study focussed on the effects of braking and pitching of the impacting vehicle. Developmental work on the door inner energy absorbing panel was confined mostly to exploration of the potential usefulness of certain simulation models. The vehicle structural simulation model was expanded to include the interaction between dummy torso and the vehicle sidewall masses. A passive airbelt restraint system was mocked up in one of the base vehicles. Potential packing problems were identified. Efforts continued with the development of the inflatable belt restraint system with limited effort also directed toward the development of preliminary design concepts for both the knee bar and load limiters. Modest effort also continued using the 3-D crash victim model to simulate various frontal collision exposures. A variety of testing activities in support of the bumper, structural, and restraint system design efforts were performed: body block tests with a foam rubber sample cut to resemble the outermost two feet of the RSV; a crush test on the front rails of the base vehicle using a pole obstacle ram face; static loading determination of the lateral torso compliance properties of a Part 572 dummy; sled tests for restraint development and support; development of a body buck for the next series of sled testing; and braking and fuel economy testing for the base vehicle.

Calspan Corp., Buffalo, N.Y. 14221
Contract DOT-HS-5-01214
Rept. No. PR-4 ; 1976 ; 32p
Availability: Reference copy only

HS-801 859

CLASSIFICATION OF FULL-SIZE AND SUBCOMPACT AUTOMOBILE FRONTAL STIFFNESS BY IMPACT TESTING. PROGRESS REPORT NOS. 1- 10, 14 APRIL 1975 TO 15 FEBRUARY 1976

A project is being undertaken to select through available data a limited number of candidate full-size and subcompact cars which have front structural stiffness characteristics that can be classified into one of four categories and to test the candidate vehicles in frontal rigid barrier impacts and car-to-car impacts in order to finalize the selection of the following vehicles: a full-size vehicle with a stiff front structure; a full size vehicle with a nominal structure; a full size vehicle with a soft front structure; and a crashworthy subcompact vehicle. The following subcompact vehicles were selected for barrier impact testing: AMC Pacer, Audi 100 LS, Mazda RX4, Mercury Capri II, Volvo 2, 1974 Ford, Honda CVCC, and VW Rabbit. Data on the weights, speeds, and deformation of the cars for the car-to-car impact tests conducted on these vehicles are presented for each of the reporting periods in which such testing took place. Two mini-compacts—Chevette and Renault RX-5—were also tested in car-to-car impacts and barrier impacts. Data collected on the impact tests included: vehicle and dummy accelerations, motion picture films, and pre- and post-test one-quarter scale drawings of the test vehicle interiors. A measure of the relative crashworthiness performance of the various vehicles tested, the Restraint Survival Distance, is determined by the relationship between the available interior occupant stroking distance based on post-crash vehicle interior dimensions and the absolute displacement of the occupant and of the vehicle compartment from initial impact to the time at which the occupant velocity equals the compartment velocity. No barrier to car crash tests were performed with full-size and/or intermediate automobiles since the results of the frontal stiffness analysis provided data sufficient for the purposes of the National Highway Traffic Safety Administration.

Calspan Corp., Buffalo, N. Y. 14221
Contract DOT-HS-5-01099
Rept. No. PR-1; PR-2; PR-3; PR-4; PR-5; PR-6; PR-7; PR-8;
PR-9; PR-10 ; 1976 ; 111p
Availability: Reference copy only

HS-801 862

ASAP REHABILITATION SYSTEMS DESCRIPTION AND ANALYSIS. PRELIMINARY REPORT

An analysis of the Alcohol Safety Action Project (ASAP) system is being conducted to: identify and describe the subsystems and their relationship; investigate systems interactions with regard to their possible effects on the performance and effectiveness of the rehabilitation subsystem, and specify the interactive effects in terms of quantitative and qualitative variables; evaluate the rehabilitation subsystem, specifying quantitative and qualitative variables which could affect the performance and effectiveness of the treatment modalities, and the information necessary for a complete description of each; specify measures of performance, efficiency, and effectiveness, both direct and indirect, for the rehabilitation subsystem; and develop questions which will obtain the desired information and compile these questions in a system description form to be sent to each project site. An overview of the system analysis and description process is presented and an attempt is made to summarize ASAP rehabilitation. A

questionnaire for alcohol safety schools and group therapy, a copy of a system description form, and descriptive rehabilitation summaries for each project site are included.

University of South Dakota, Human Factors Lab.
Contract DOT-HS-191-3-759
1974; 204p
Availability: NHTSA

HS-801 863

EVALUATION OF A THREE-POINT HARNESS WITH LAP BELT ATTACHED TO SEAT. TEST REPORT NO. 2. CALMAN 2

A sled test was conducted with unembalmed cadavers to evaluate the effectiveness of a three-point belt restraint system with the ends of the lap belt attached directly to the seat rather than to the vehicle frame. Particular attention was given to abdominal trauma associated with the excessive abdominal loading which occurs when the lap belt slips above the iliac crest during a crash. A Citroen Corporation restraint system, seat, and internal compartment geometry were used for this test. Calspan's HYGIE impact sled facility was used to accelerate the body buck, test subject, and equipment to a velocity of 30.4 mph. The cadaver sustained multiple thoracic cage fractures as well as abdominal soft tissue injuries. The major injuries included: multiple fractures of the right and left halves of the thoracic cage, including multiple fractures of the sternum; massive laceration of the liver that penetrated deep into the substance of the organ; and small lacerations of the peritoneal wall at the level of ribs numbers 9 and 10, with superficial capsular laceration of the spleen. Instrumentation recorded levels of acceleration at the head above those accepted as fatal limits. The multiple rib fractures, sternum fractures, liver laceration, and spleen laceration would probably have caused death. The lap and shoulder belts showed normal belt loads for a subject of the size used. While the clavicles were cracked, there were no injuries noted to the ilium, ischium, or pubis. The arterial pressure peak of 1,760 millimeters of mercury was considered high, but the autopsy showed no cardio-vascular damage. The medical report is included.

Calspan Corp., Buffalo, N.Y. 14221
Contract DOT-HS-5-01017
1975; 32p
Availability: NHTSA

HS-801 864

EVALUATION OF A THREE-POINT HARNESS WITH LAP BELT ATTACHED TO SEAT. TEST REPORT NO. 3. ANTHROPOMORPHIC DUMMY

A sled test using a Humanoid Systems 50th percentile anthropomorphic dummy to evaluate a three-point harness with the lap belt attached to the seat was conducted to compare kinematics and loadings of the Calman II dummy and the current production dummy. Calspan's HYGIE impact sled facility was used for this test to accelerate the body buck, dummy, and equipment to a velocity of 30.2 mph. External accelerometers were attached to the head and chest of the dummy and the standard triaxial accelerometer packages were installed inside the head and chest for direct comparison with external instrumentation. A rotary potentiometer connected to a movable arm was used to measure chest deflections. Four high-speed movie cameras were used to record the motions of

the dummy. Belt elongation was measured. External as well as internal instrumentation recorded levels of acceleration at the head below those accepted as fatal limits. A resonance in the accelerometer package seems to be set up at about .095 seconds in the test of Calman II as compared to tests with the Humanoid Systems dummy. This resonance phenomenon may have caused the extremely high Head Injury Criterion number of 7,925 on Calman II. The 50th percentile dummy tested in these runs was very close in size to the Calman II. Since the kinematics of the two test subjects, on impact, are very similar and the chest instrumentation recorded levels very close, it is concluded that it is reasonable to assume from the photographs that the shoulder strap is doing the internal damage to the cadavers.

Calspan Corp.
Contract DOT-HS-5-01017
1975; 21p
Availability: NHTSA

HS-801 865

EVALUATION OF A THREE-POINT HARNESS WITH LAP BELT ATTACHED TO SEAT. TEST REPORT NO. 4. CALMAN 3

A sled test was conducted with unembalmed cadavers to evaluate the effectiveness of a three-point safety belt restraint with the ends of the lap belt attached directly to the seat rather than to the vehicle frame. A Citroen Corporation restraint system, seat, and internal compartment geometry were used for the test. Particular attention was given to the injury patterns associated with three-point lap and shoulder belt restraints involving abdominal trauma associated with the excessive abdominal loading which occurs when the lap belt slips above the iliac crest during a crash. Calspan's HYGIE impact sled facility was used to accelerate the body buck, test subject, and equipment to a velocity of 30.1 mph. The cadaver sustained multiple bony as well as abdominal soft tissue injuries. Instrumentation recorded levels of acceleration at the head above those accepted as fatal limits. Although the chest peak acceleration measurement was 62 accelerations of gravity with a Chest Severity Index of 500, the damage to the rib cage and liver laceration would probably cause death. These notwithstanding, the complete transection of the root of the aorta would definitely be fatal.

Calspan Corp.
Contract DOT-HS-5-01017
1975; 59p
Availability: NHTSA

HS-801 866

EVALUATION OF A THREE-POINT RESTRAINT AIR BELT SYSTEM. TEST REPORT NO. 5. CALMAN 4

A sled test was conducted with unembalmed cadavers to evaluate the effectiveness of a three-point belt restraint system in which the shoulder strap is inflated at impact to better distribute the loading. Particular attention was given to the injury patterns associated with three-point lap and shoulder restraints which involve abdominal trauma associated with excessive abdominal loading which occurs when the lap belt slips above the iliac crest during a crash. A Minicars air belt system was used with a Pinto body buck and seat for this test. Calspan's HYGIE impact sled facility was used to accelerate the body

August 31, 1976

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buck, test subject, and equipment to a velocity of 46.7 mph. The cadaver sustained several fractures of the right and left halves of the anterior thoracic cage. The fracture of the ribs as a group were undisplaced and frequently incomplete, extending only partially through the height or through only the external (subcutaneous, ventral) surface. Fracture of the lateral aspect of the left clavicle with separation of the acromioclavicular joint was shown in x-ray studies. Aortic valvular prosthesis and hepatosplenomegaly were also noted. Instrumentation recorded levels of acceleration at the head below those accepted as fatal limits. Although the chest peak acceleration measurement was 68 accelerations of gravity, if a 3 millisecond exclusion were taken the level would be below 50 accelerations of gravity. This coupled with a Chest Severity Index (CSI) of 600 and the medical report of rib fractures as a group being undisplaced and frequently incomplete must lead to the interpretation that this 46.7 mph crash would have been painful but not life-endangering.

Calspan Corp.
Contract DOT-HS-5-01017
1975 ; 31p
Availability: NHTSA

HS-801 867

EVALUATION OF A THREE-POINT RESTRAINT AIR BELT SYSTEM. TEST REPORT NO. 6. CALMAN 5

A sled test was conducted using an unembalmed cadaver to evaluate the effectiveness of a three-point belt restraint system in which the shoulder strap is inflated at impact to better distribute the loading. Particular attention was given to abdominal injuries associated with the excessive abdominal loading which occurs when the lap belt slips above the iliac crest during a crash. A Minicars air belt system was used with a Pinto body buck and seat for this test. Calspan's HYGIE impact sled facility was used to accelerate the body buck, test subject, and equipment to a velocity of 46.9 mph. The cadaver sustained a minimum of injury, with a fracture of left rib number 4, which was in the same area as a faint overlying subcutaneous discoloration. This information, coupled with the fact that petechial hemorrhages were also present in the pericardial sac, suggests that they, as well as the fracture of the rib, may have been caused by terminal external cardiac massage rather than by the Calspan sled impact. Instrumentation recorded levels of acceleration at the head below those accepted as fatal limits. The chest peak acceleration measurement was 47.5 accelerations of gravity. This information coupled with a Chest Severity Index (CSI) of 510 and the medical report of one rib fracture possibly caused by terminal external cardiac massage lead to the conclusion that this 46.9 mph crash may have been painful but not life-endangering.

Calspan Corp.
Contract DOT-HS-5-01017
1975 ; 22p
Availability: NHTSA

HS-801 868

EVALUATION OF A THREE-POINT RESTRAINT AIR BELT SYSTEM. PROGRESS REPORT 6. 1 JULY 1975 TO 31 AUGUST 1975

A sled test was conducted using an unembalmed cadaver

Test conditions on the sled were 34 peak accelerations of gravity, giving a velocity change of 46.9 mph. The subject was a 51 year old male weighing 150 pounds, with a standing height of 63.5 inches. The cadaver sustained a Head Severity Index (HSI) of 1,144 and a Chest Severity Index (CSI) of 510. The injuries observed in the post impact autopsy included a fracture of rib 4 on the left side.

Calspan Corp., Buffalo, N.Y. 14221
Contract DOT-HS-5-01017
Rept. No. PR-6 ; 1975 ; 3p
Availability: NHTSA

HS-801 869

EVALUATION OF A THREE-POINT HARNESS WITH LAP BELT ATTACHED TO SEAT. TEST REPORT NO. 1. CALMAN 1

A sled test was conducted using an unembalmed cadaver to evaluate the effectiveness of a three-point belt restraint system in which the ends of the lap belt were attached directly to the seat rather than to the vehicle frame. Particular attention was given to the abdominal injuries associated with the excessive abdominal loading which occurs when the lap belt slips above the iliac crest during a crash. A Citroen Corporation restraint system, seat, and internal compartment geometry were used for the test. Calspan's HYGIE impact sled facility was used to accelerate the body buck, test subject, and equipment to a velocity of 30.4 mph. The subject sustained multiple cranial and thoracic cage injuries. Major injuries included: multiple fractures of the anterior right and left halves of the thoracic cage, as well as of the sternum; multiple fractures of the right orbit and its supporting skeletal structures; fractures of the cranium regionally associated with the orbit and secondary laceration of the frontal lobe of the brain; and superficial laceration of the liver, probably secondary to fracture of rib number 9, and superficial hematoma of the liver. Instrumentation recorded levels of acceleration, at both the head and upper thoracic regions, above those accepted as fatal limits. The frontal lobe of the brain was lacerated by a fracture of the sphenoid bone. This laceration, combined with the multiple rib fractures, sternum fractures, and the liver laceration, would probably have caused death. The lap belts, being mounted to the seat, showed smaller than expected belt loads. This is attributed to the seat track yielding, thereby absorbing some of the energy. There were no injuries noted to the ilium, ischium, or pubis. Detailed information on the sled test facility and on the data gathering, recording, and reduction system is included in appendices to this report.

Calspan Corp.
Contract DOT-HS-5-01017
1975 ; 61p
Availability: NHTSA

HS-810 293

STATEMENT BEFORE THE SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS, COMMITTEE ON FOREIGN AND INTERSTATE COMMERCE, UNITED STATES HOUSE OF REPRESENTATIVES, FEBRUARY 27, 1976

Testimony of the Administrator of the National Highway Traffic Safety Administration (NHTSA) before a Congressional

reform is presented. The National Traffic and Motor Vehicle Safety Act authorizes NHTSA to issue standards improving the safety of new vehicles and to secure the elimination of safety defects in vehicles on the road. The Act also provides the authority for a variety of consumer information efforts. Uniform standards for state highway safety programs have been developed and Federal funds have been provided to help states administer such programs, which focus on developing safer drivers, safer roads, and safer vehicles-in-use. Traffic fatalities have been reduced significantly since the passage of the Highway Safety Act of 1966. Cost/benefit analysis in the area of traffic safety is relatively difficult due to the problems of quantifying the values of human injuries and deaths and overall societal benefits and costs. Also, technological problems are involved in the development of motor vehicle safety equipment and standards. Data on pre-crash, crash, and post-crash environments are not as complete as would be desirable for determining causes of accidents and injuries. The industry has been the major source of information regarding the costs of safety regulation and the time necessary for implementation. Legal and procedural requirements also slow the implementation of regulatory activities. It is concluded that the major problems faced by the NHTSA are substantive rather than procedural. The most important area of safety regulation and development at the present time is the improvement of occupant restraint systems.

by James B. Gregory
National Hwy. Traffic Safety Administration
1976 ; 24p
Availability: Corporate author

ments which might help lower the severity of injuries received in such accidents. NHTSA has been quite active in the area of standards enforcement and safety defects, both testing vehicles and equipment and ordering recall campaigns. The Research Safety Vehicle program continues to investigate and anticipate the transportation requirements for the 1980's in terms of both safety and energy.

by James B. Gregory
National Hwy. Traffic Safety Administration
1976 ; 17p
Availability: Corporate author

HS-810 294

**STATEMENT BEFORE THE SUBCOMMITTEE ON
CONSUMER PROTECTION AND FINANCE,
COMMITTEE ON INTERSTATE AND FOREIGN
COMMERCE, UNITED STATES HOUSE OF
REPRESENTATIVES ON MARCH 4, 1976**

Testimony of the Administrator of the National Highway Traffic Safety Administration (NHTSA) to a Congressional Committee on a bill (H.R. 9291) to authorize funds to implement the National Traffic and Motor Vehicle Safety Act is presented. It is reported that there has been a continuous and significant decline in the nation's highway fatality rate since the institution of the first Federal Motor Vehicle Safety Standards in 1967. It is suggested that motor vehicle safety programs have contributed most to the safety gains achieved. Additional significant decreases in traffic fatalities can be achieved in the near future through greatly increased use of present and improved active safety restraint systems or through the provision of passive restraint systems. These passive restraints can consist of interior padding, collapsible steering wheels, head restraints, air bags, knee bolsters, and other similar features. The increased use of smaller cars poses increased potential for death and serious injury in traffic accidents, and methods for meeting these problems are being investigated. Standards related to air brake systems which have been proposed by NHTSA have been challenged in court and are awaiting resolution. Problems with brake anti-lock systems are being investigated. Final safety standards have been issued in accordance with the directives of the Schoolbus Safety Amendments of 1974. The burn rate of interior materials used in vehicles has been extensively investigated. The fundamental problems of pedestrian injuries and deaths from motor vehicles are being studied to determine vehicle design require-

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Human Factors Res., Inc., Santa Barbara Res. Park, 6780 Cortona Drive, Goleta, Calif. 93017

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District of Columbia Dept. of Highways and Traffic, Traffic Res. Section, District Bldg., 415 12th St., N.W., Washington, D.C. 20004

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Systems Technology, Inc., 13766 South Hawthorne Blvd., Hawthorne, Calif. 90250

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Kentucky Bureau of Highways, Div. of Res., 533 South
Limestone, Lexington, Ky. 40508
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Stanford Res. Inst., 333 Ravenswood Ave., Menlo Park,
Calif. 94025
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University of Southern California, Industrial and Systems
Engineering, Los Angeles, Calif. 90007
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University of Texas, Center for Cybernetic Studies, Austin,
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Budd Co.; Naval Air Devel. Center, Warminster, Pa. 18974
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General Electric Co., Information Systems Programs, 1755
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Ref: DOT-HS-4-00909
General Electric Co., Information Systems Programs, 1755
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Ref: DOT-HS-4-00910
General Electric Co., Information Systems Programs, 1755
Jefferson Davis Hwy., Arlington, Va. 22202
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